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MYCOLOGIA

VOL. XXI JANUARY–FEBRUARY, 1929 NO. 1

MRS. FLORA WAMBAUGH PATTERSON

VERA K. CHARLES

(WITH TEXT FIGURE 1)

Mrs. Flora Wambaugh Patterson, for many years mycologist in the Department of Agriculture, died at the home of her son, Henry Sells Patterson, in Brooklyn, N. Y., February 5, 1928.

MRS. FLORA W. PATTERSON IN HER LABORATORY

It was Mrs. Patterson's privilege to belong to that little group of scientists constituting what was known in those early days

as the Division of Vegetable Pathology and Physiology, the nucleus from which the Bureau of Plant Industry has developed.

Mrs. Patterson was born in Columbus, Ohio, Sept. 15, 1847, and was the daughter of a Methodist minister, Rev. A. B. Wambaugh and Sarah Sells Wambaugh. She studied at Antioch College, graduating with the degree of A.B. in 1860, and later, in 1865, at Wesleyan College, Cincinnati, from which she received the degree of A.M. in 1883. She attended the University of Iowa in 1895, receiving the A.M. degree. In 1896 she was instructor in biology in a Boston private school.

Her marriage to Capt. Edwin Patterson took place Aug. 12, 1869. A few years after her marriage, Mr. Patterson was injured in a steamboat explosion from which he never recovered but lived ten years, a helpless invalid. After his death and while preparing her two sons for college Mrs. Patterson took up Biology at the State University of Iowa where her brother was a professor. There her active interest in botanical subjects may be said to have begun. In 1893 her brother was called to the Harvard Law School and Mrs. Patterson wishing to be near him and place her sons in a preparatory school decided to continue her studies at Yale University. Thinking all conditions for pursuing work at Yale had been arranged, she went there only to find the doors closed against her, women not being eligible at that time. In spite of the keen disappointment and inconvenience she persisted in her desire to continue botanical investigations, and, going to Cambridge, registered for work at Radcliffe College. There she remained for three years, 1892–1895, taking courses in botany and working as an assistant in the Gray Herbarium. Mrs. Patterson's training in Plant Pathology and herbarium methods was acquired during this period.

Mrs. Patterson took a Civil Service examination about 1895 and in 1896 was appointed Assistant Pathologist in the Department of Agriculture. She later became Mycologist in Charge of Mycological and Pathological Collections and retained that position until her retirement in 1923. Mrs. Patterson had a great respect for conscientious scientific investigations and her work was characterized by exactness and attention to details. No phase of a problem was too minor to justify her best attention

and endeavor. Her general knowledge of fungi was broad and a few groups had received her best attention. She had given particular attention to Exoascaceae, and published a paper in 1895 on this family. Her other contributions appeared as Department bulletins and a few articles in outside publications.

One of Mrs. Patterson's most prominent characteristics was her very active up-to-the-minute interest and knowledge of the trend of modern thought. Though born in the early half of the last century she had been able to bridge the early period of conservatism or intolerance of too advanced scientific thought and action and present an open mind to the examination of the modern interpretation of science and other branches of progressive thought.

Mrs. Patterson's courtesy and generosity were well known. In addition she possessed to a high degree a sympathetic nature and few appeals for help or advice, whether or not worthy, failed to receive kindly attention.

The last years were passed in reading as much as failing eyesight permitted. Her active interest in all lines of progress and pleasure in the discussion of current events as well as the very keen interest in the welfare of her friends remained until the last. One of her last spoken requests was to express her appreciation of her many friends in the Department of Agriculture with whom she had been associated so many years.

Connected with many scientific organizations, Mrs. Patterson was a Fellow of the American Association for the Advancement of Science; Member of the Botanical Society of America; National Geographic Society; Washington Botanical Society; Biological Society of Washington; American Phytopathological Society; and American Association of University Women. She was a contributor of bulletins of the U. S. Department of Agriculture, and of articles in scientific journals, and Assistant Editor of Economic Fungi, in 1895.

Mrs. Patterson is survived by her brother, Eugene Wambaugh, Professor Emeritus of Law at Harvard University.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

PUBLICATIONS OF FLORA W. PATTERSON

Species of *Taphrina* parasitic on *Populus*. Bot. Gaz. **19:** 380. 1894. (Abstract of paper read before the American Association for the Advancement of Science.) Also published in Proc. Am. Assoc. Adv. Sci. **43:** 293–294. 1895.

A study of North American parasitic Exoascaceae. Iowa Univ. Bull. Lab. Nat. Hist. **3:** 89–135, illus., 1895.

New species of fungi. Bull. Torrey Club **27:** 282–286. 1900.

Some woody fungi. Asa Gray Bull. **8:** 13–19. 1900.

A collection of economic and other fungi prepared for distribution. U. S. Dept. Agri. Bur. Pl. Ind. Bull. 8, 31 p. 1902.

Septoria spadicea Patterson & Charles in Spaulding, P. The present state of the white-pine blights. U. S. Dept. Agr. Bur. Pl. Ind. Circular 35: 4. 1909.

A fungus enemy of mushroom growing. Science n. s. **31:** 756. 1910. (Abstract of paper read before the American Phytopathological Society.)

Some fungous diseases of economic importance. I. Miscellaneous diseases. II. Pineapple rot caused by *Thielaviopsis paradoxa*. U. S. Dept. Agr. Bur. Pl. Ind. Bull. 171, 41 p., *8 pl.*, 1910. (V. K. Charles and F. J. Veihmeyer, joint authors.)

Stemphylium Tritici sp. nov., associated with floret sterility of wheat. Bull. Torrey Club **37:** 205. 1910.

An edible smut. Phytopathology **2:** 93. 1912. (Abstract of paper read before the American Phytopathological Society.)

Mushrooms and other common fungi. U. S. Dept. Agr. Bull. 175, 64 p., *38 pl.*, 1915. (V. K. Charles, joint author.)

Diseases of roses in Mulford, F. L. Roses for the home. U. S. Dept. Agr. Farmers' Bull. 750: 34–36. 1916, revised 1921.

The occurrence of bamboo smut in America. Phytopathology **6:** 351–356, illus., 1916. (V. K. Charles, joint author.)

Some common edible and poisonous mushrooms. U. S. Dept. Agr. Farmers' Bull. 796, 24 p., illus., 1917, revised 1922. (V. K. Charles, joint author.)

A list of fungi (Ustilaginales and Uredinales) prepared for exchange. U. S. Dept. Agr. Circular 195: 1–50, 1922. (W. W. Diehl and E. K. Cash joint authors.)

Rose diseases and their prevention. Florida Fruits and Flow. **2:** 37–38. 1925. (From Farmers' Bull. 750.)

NORTH AMERICAN SPECIES OF SCLEROTINIA II.[1]—TWO SPECIES ON CAREX, S. DURIAEANA (TUL.) REHM, AND S. LONGISCLEROTIALIS N. SP.

H. H. Whetzel

(With plates 1–5 and 1 text figure)

Although a number of species of *Sclerotinia* have been recorded as occurring on *Carex* in Europe, it is interesting that heretofore none have been reported as such from North America. In 1918 the writer first collected a species of *Sclerotinia* on *Carex* growing in the water of an open swamp near McLean, N. Y. This is here described as a new species under the name *S. longisclerotialis*. A second species which is here provisionally referred to *S. Duriaeana* of Europe was collected along with the first in the spring of 1921. Both species have been repeatedly taken nearly every season since, in this and other *Carex* swamps in this region. During the spring and summer of 1925, 1926, and 1927 a careful investigation of the occurrence and life history of these two species of *Sclerotinia* was undertaken. This has been supplemented by morphological studies and by extensive culture work with these fungi on artificial media. The observations thus accumulated, while by no means complete, seem sufficient to afford a fairly accurate picture of the identity and the life history of each species.

Sclerotinia Duriaeana (Tul.) Rehm, Hedwigia **21:** 66. 1882

Before presenting the results of our studies on the American form which is here provisionally referred to *Sclerotinia Duriaeana*,

[1] The investigations upon which this paper is based were supported by a grant from the Heckscher Foundation for the Advancement of Research established by August Heckscher at Cornell University. The writer wishes to acknowledge also the assistance of Miss Cynthia Westcott, who as Heckscher Research Assistant has materially contributed to the success of these investigations. The photographs were taken by W. R. Fisher; the drawings were made by Miss Westcott.

it seems desirable to present the evidence in what appears to be an anomalous situation in respect to the application of this name to European forms.

SYNONYMY AND IDENTITY OF SCLEROTINIA DURIAEANA

The synonymy of *Sclerotinia Duriaeana* is much confused at several points. The attempt to unravel these tangles has involved an amount of time and labor out of all proportion to the number of names cited in the list below. However this work has disclosed a situation which appears to be of peculiar interest and importance. It suggests, to the writer at least, that there are two species commonly referred to *S. Duriaeana* which heretofore have not been distinguished. The most striking difference between the two forms appears to lie in the character of their microconidial sporodochia. For convenience and ease in understanding the following discussion we may designate these the **affine** and the **ambiens** forms.

The **affine** form produces, in the culms of its *Carex* hosts, microconidial sporodochia which are narrow, linear, dull olivaceous black, and irregularly scattered along one or two faces of the 3-angled culm (FIG. 2).

In the **ambiens** form the sporodochia are oval, short, dark brown or black, polished, swollen and grouped around the culm at regular intervals (FIG. 9).

Names applied to these two forms in literature.

Affine form

Sclerotium sulcatum Roberge in herb.: Desm. Ann. Sci. Nat. III. **16:** 329. 1851. **Exs.** Desm. Pl. Crypt. Fr. ser. I. ed. 1, *2029;* ser. I. ed. 2, *1629.*

Epidochium affine Desm. in part (excluding specimens on *Schoenus*) Ann. Sci. Nat. III. **20:** 232. 1853. **Exs.** Desm. Pl. Crypt. Fr. ser. II, *21.*

Claviceps (?) *caricina* Griffiths, Bull. Torrey Club **29:** 300. 1902. **Exs.** West Am. Fungi, *400.*

Ambiens form

Epidochium ambiens Desm. Ann. Sci. Nat. III. **20:** 231. 1853. **Exs.** Desm. Pl. Crypt. Fr. ser. II, *20.*

Peziza Duriaeana Tul. Sel. Fung. Carp. **1:** 103. 1861, and **3:** 203, *pl. 22, fig. 20–24.* 1865. **Exs.** Tulasne type material. Mus. Paris.

Sphacelia nigricans (Tul.) Sacc. Michelia **2:** 131, in part. 1880. **Exs.** Roumg. Fung. Gallici, *1200.* (As to plant described; not the conidial stage of *Claviceps nigricans* Tul. upon which the name is based.)

Sclerotium nigricans (Tul.) Sacc. Michelia **2:** 134, in part. 1880, and Syll. Fung. **14:** 1153. 1899. **Exs.** Roumg. Fung. Gallici, *1200.* (As to plant named; not sclerotial stage of *Claviceps nigricans* Tul. upon which name is based.)

Sphacelia ambiens (Desm.) Sacc. Syll. Fung. **4:** 666. 1886. **Exs.** Roumg. Fung. Gallici, *1200.*

Sclerotinia Duriaeana (Tul.) Rehm, Hedwigia **21:** 66. 1882. (As to name only; Rehm: Ascomyceten, *603,* which is here described and cited by Rehm is of the **affine** form.)

Sclerotinia Duriaeana (Tul.) Sacc. Syll. Fung. **8:** 199. 1889.

Hymenoscypha Duriaeana (Tul.) Phillips, Manual Brit. Discom. 115. 1893.

The specimen cited after a name in the above list is the specimen which we believe the author had before him or in mind when applying his name.

In Desmazières' description of *Sclerotium sulcatum* (1851) he says it is "found inside the triangular stubble of *Carex vulpina* and *C. acuta,* and on one or two species with cylindrical culms." We have examined both the specimens cited by Desmazières (*2029* and *1629*). These show only short pieces of culms containing sclerotia and in one case microsporodochia. Specimens of *2029* in the Farlow Herbarium are mounted open on one page of the fascicle. There are two labels. Most of the specimens are said to be on *Schoenus nigricans* though this host is not mentioned in the original description. These show sclerotia only. Two pieces of culms also containing sclerotia only are labelled "*Carex vulpina* et *acuta.*" This same number in the N. Y. Bot. Gard. Herbarium is in a packet and consists of a few pieces of culms showing both sclerotia and sporodochia of the **affine** form. The label on this specimen says on "*Carex vulpina* et *acuta.*" Speci-

mens of *1629* in the Farlow Herbarium also consist of short pieces of culms containing sclerotia only. The label says on "*Carex vulpina* et *acuta*." It seems clear to the writer, judging from Desmazières' description, an examination of the sclerotia in these specimens and the presence of linear microsporodochia in some of the culms, that Desmazières was dealing with a *Sclerotinia* of the **affine** form.

Two years later Desmazières (1853) described the sporodochial stage of a *Sclerotinia* under the name *Epidochium ambiens*, basing it upon material collected by Roberge (Desm. Pl. Crypt. Fr. ser. II, *20*). The host is given as *Carex*, with no specific designation. Dr. K. M. Wiegand of Cornell University has examined the specimen and thinks it is undoubtedly *Carex paniculata* L. There are no sclerotia in these culms. The sporodochia are abundant and of a strikingly different form from those in the specimens of *Sclerotium sulcatum* referred to above. It is on this specimen that we have founded our **ambiens** form.

At the same time and on the next page Desmazières (1853: 232) described *Epidochium affine*, citing his specimen, number *21*, ser. II. Pl. Crypt. de France. There are two specimens accompanying one label under this number. One packet contains culms and fruiting heads of *Schoenus nigricans* L. These show sporodochia-like bodies, which differ however very distinctly from the sporodochia in the other packet on the culms of what is, according to Dr. K. M. Wiegand, *Carex Hudsonii* Bennett (*C. stricta* Good.). The sporodochia on the *Carex* culms are identical in appearance with those accompanying *Sclerotium sulcatum* in Desm. Pl. Crypt. Fr. ser. I. ed. 1, *2029*, referred to above. Desmazières (1853: 232) says (Transl.): "This small fungus, which, perhaps, is only a variety of the preceding species (referring to *E. ambiens*), is only distinguished by acervuli which do not envelop the culm. They are located on the same side and are not spaced regularly with equal intervals. *Epidochium affine* is often found with *Sclerotium sulcatum*." Since the label accompanying these two packets specifies, as hosts of *E. affine*, not only *Schoenus nigricans* but also "plusieurs Carex," as does also Desmazières' description, it is evident that he regarded the sporodochia on both hosts as one and the same fungus. However

his description of the sporodochia fits those on the *Carex* rather than those on *Schoenus*, for he says: "Acervulis linearibus parallelis." Those on *Schoenus* are broad, almost circular. That the fungus on *Schoenus nigricans* is the same as that on the *Carex* the writer doubts. No *Sclerotinia* appears to be recorded on *Schoenus nigricans*. The sporodochia on the *Carex* culms are undoubtedly to be referred to *Sclerotinia Duriaeana* and constitute the type of our **affine** form.

Through the kind offices of Monsieur Föex of the Station Centrale de Pathologie Végétale, the Director of the Muséum d'Histoire Naturelle in Paris, Monsieur Mangin, has been so good as to loan us for examination Tulasne's specimens of the sclerotial stage of his *Peziza Duriaeana* on *Carex arenaria* L. A single short piece of culm shows the typical sporodochia as pictured by Tulasne. The sclerotia are allantoid and distinctly more slender than those of the **affine** form. They average (42 measurements of dry sclerotia) 8.5 mm. × 1.2 mm. (Compare FIGS. 7 AND 8.)

Saccardo has further confused the situation in as far as it affects the sclerotial and sporodochial stages. There is a specimen in Roumeguère's Fungi Gallici, *1200*, bearing the name *Sclerotium nigricans* (Tul.) Sacc. with the citation, "Michelia VI, p. 134." (The "VI" is a misprint for "II.") An examination of this specimen discloses a culm of *Carex paniculata*, bearing the microconidial sporodochia and a sclerotium of what is undoubtedly the **ambiens** form of *Sclerotinia Duriaeana*. Saccardo, who evidently identified the specimen, refers it erroneously to *Claviceps nigricans* Tul. (Tulasne 1853: 51). Now, based upon this single specimen, he (Michelia **2:** 131, 134. 1880) erects two species, *Sphacelia nigricans* (Tul.) Sacc. and *Sclerotium nigricans* (Tul.) Sacc., to designate what he takes to be two asexual stages of *Claviceps nigricans* Tul. Saccardo's first publication (1880) of the name *Sclerotium nigricans* is unaccompanied by a description. When he later listed this species in the Sylloge (1899) he added a brief description. Here, he gives *Sclerotium Eleocharidis* Thüm. as a synonym and cites Thümen's specimen, *2298*, in Mycotheca Universalis, which is however actually the sclerotial stage of *Claviceps nigricans* Tul. Meanwhile (1886),

having decided that his *Sphacelia nigricans* is identical with *Epidochium ambiens* of Desmazières, he makes the new combination *Sphacelia ambiens* (Desm.) Sacc. but still persists in his erroneous notion that it is the conidial stage of *Claviceps nigricans* Tul. While the descriptions accompanying the names *Sclerotium nigricans* and *Sphacelia nigricans* are in fact based upon the microconidial and sclerotial stages respectively of the **ambiens** form of *S. Duriaeana* as represented in Roumeguère's specimen, *1200*, the names are to be regarded as synonyms of *Claviceps nigricans* Tul. rather than of *S. Duriaeana*.

Both the **affine** and the **ambiens** forms occur in Europe. Thus far only the **affine** form has been found in America, where it is apparently most abundant on *Carex stricta* Lam., though as we shall see later it is not uncommon on a number of other *Carex* species. In Europe the **affine** form would appear to be most common on *Carex Hudsonii* Bennett (*Carex stricta* Good.), although the type specimen of *Sclerotium sulcatum* which has sporodochia of this type was described from *Carex vulpina* L. and *Carex gracilis* Curt. (*C. acuta* L.). The **ambiens** form is the one which Tulasne had in hand when he pictured and described *Peziza Duriaeana* on *Carex arenaria* L. It seems to occur most commonly on *Carex paniculata* L.

The exsiccati specimens of European material of the sporodochial and sclerotial stages which we have been able to examine and upon which the above discussion is based are listed below. The institutional herbaria in which the particular specimens examined are deposited are indicated in each case thus: **N. Y. B. G.** (New York Botanical Garden); **Harvard** (Farlow Cryptogamic Herbarium at Harvard University); **U. S. D. A.** (Mycological Collections, U. S. Dept. Agr.); **C. U. Atk., C. U. Durand,** and **C. U. Pl. Path.** (the Atkinson collection, the Durand collection and the Plant Pathology collection respectively at Cornell University).

Specimens of the **affine** form:

Desmazières: Pl. Crypt. de France, ser. 2, **21,** *Epidochium affine* Desm. (type in part) on *Carex* (*Hudsonii* Bennett ?) (sporodochia only). **N. Y. B. G., Harvard.**

Desmazières: Pl. Crypt. de France, ser. I. ed. 1, *2029*

(type) *Sclerotium sulcatum* Rob. in herb. on *Carex vulpina* L. and *C. acuta* L. (sclerotia and sporodochia). **N. Y. B. G., Harvard;** ser. I. ed. 2, *1629.* **Harvard.**

Lindhart: Fungi hungarici. *381 Peziza Duriaeana* Tul. on *Carex* (*Hudsonii* Bennett ?) (sclerotia and sporodochia). **N. Y. B. G., U. S. D. A.**

Specimens of the **ambiens** form:

Desmazières: Pl. Crypt. de France, ser. 2, **20,** *Epidochium ambiens* Desm. (type) on *Carex* (*paniculata* L.) (sporodochia only). **N. Y. B. G., Harvard.**

Tulasne, Ergot caulinaire des Carex arenaria. Prairie de Fargues, près Langon (Gironde) 24 Juni, 1860. Part of type of *Peziza Duriaeana* Tul. **Herb. Mus. Paris.**

Roumeguère: Fungi Gallici exs. *1200 Sclerotium nigricans* (Tul.) Sacc. on *Carex paniculata* L. (sclerotium and sporodochia). **C. U. Pl. Path., N. Y. B. G.;** *3505 Epidochium affine* Desm. on *Carex paniculata* L. (sporodochia only). **N. Y. B. G., Harvard.**

Roumeguère: Fungi selecti exs. *4600 Sclerotium sulcatum* Rob. on *Carex paniculata* L. (sclerotium only, immature). **Harvard, N. Y. B. G.;** *4682 Sphacelia ambiens* (Desm.) Sacc. on *Carex paniculata* (sporodochia). **N. Y. B. G., Harvard;** *5419 Sclerotinia Duriaeana* Tul. on *Carex* (*paniculata* L.) (sporodochia only). **N. Y. B. G., Harvard.**

deThümen: Mycotheca universalis, *1575 Epidochium ambiens* Desm. on *Carex paniculata* L. (sporodochia and sclerotia). **N. Y. B. G., Harvard** (sporodochia only). (FIG. 9.)

When one turns to the synonomy of the apothecial stage the confusion is hardly less disconcerting. The apothecial stage was discovered by Durieu de Maisonneuve in 1856 on the banks of the Garonne in France. Tulasne (1861: 103) to whom material was sent was the first to apply a name to the apothecial stage, calling it *Peziza Duriaeana* in honor of the collector. Tulasne's work, as he states, was based upon material on *Carex arenaria* L. collected and sent to him by Durieu in 1857, from sclerotia of which he developed apothecia during April and May, 1858.

He clearly had sporodochia in the material sent to him by Durieu as may be seen from Figs. 20–24, Pl. 22, in vol. 3 of his Selecta Fungorum Carpologia. However in his description of the species he treats only the sclerotia and apothecia (Sel. Fung. Carp. **1:** 103–104). That he regarded the sporodochia on *C. arenaria* as identical with *Epidochium ambiens* Desm. is evident from his remarks on the matter and he raises the question whether they are not genetically related to his *Peziza*.

Tulasne seems to have had some doubt of the relation of his fungus to *Sclerotium sulcatum*. He says, speaking of the sclerotium (Transl.), "it is said to be *Sclerotium sulcatum* Rob." He also calls attention to the fact that there is another sporodochial form, *Epidochium affine* Desm., "scarcely different" from *E. ambiens* and remarks that the usual association of this with *S. sulcatum* had not escaped Desmazières. It is clear therefore that Tulasne applied the name *Peziza Duriaeana* to the **ambiens** form.

Rehm (1882) describes the apothecial stage of a *Sclerotinia* on *Carex stricta* Good. (now *C. Hudsonii* Bennett) and refers it to Tulasne's species *Peziza Duriaeana* but transfers the species to the genus *Sclerotinia*. His description of the species is based upon the specimens distributed in Rehm: Ascomyceten, *603*. No reference is made by Rehm to sporodochia. Since however all sporodochial specimens which we have seen on *C. Hudsonii* are of the linear scattered type, there can be little question but that Rehm's apothecial material belongs to the **affine** form.

Saccardo (Syll. **8:** 199. 1889) writes the combination, "*Sclerotinia Duriaeana* Tul." Since Tulasne never transferred his species, *Peziza Duriaeana*, to the genus *Sclerotinia*, this is either a careless error on Saccardo's part, or an intentional transfer which he has failed to correctly indicate. In any case it is necessary to include *Sclerotinia Duriaeana* (Tul.) Sacc. in the synonymy.

Boudier (1885) cites *Peziza Duriaeana* Tul. along with *P. tuberosa* Hedw. and *P. subularis* Bull. as examples of his sub-genus *Sclerotinia* in the genus *Ciboria*. Rehm (1896 in Rabenhorst's Kryptogamen Flora) lists *Sclerotinia Duriaeana* Quél., citing "Bull. Soc. Myc. Fr. **1:** 115," which however is the 1885 paper

by Boudier. This is either an error as to author or as to article. Rehm's treatment of the synonymy here would seem to indicate that he now had reasons to hold that Quélet should be credited with the combination *Sclerotinia Duriaeana* instead of himself.

The next investigator of this species to use the combination of authors, "(Tul.) Quél.," was Boudier (1907) in his Icones Mycologicae. He, however, cites no authority for designating Quélet as the author who made the transfer from *Peziza* to *Sclerotinia*. A most careful and exhaustive search through the numerous publications of Quélet has failed to show that this worker ever made the transfer. A similar search of Boudier's works has been equally fruitless. It seems strange indeed that Boudier, a close friend and colleague of Quélet, should be in error in this matter. Rehm's earlier use (1896) of Quélet's name as author of the transfer would also strengthen the supposition that somewhere Quélet may have made the combination now generally attributed to him. However, in view of our failure to find published evidence of this and since such a transfer was made by Rehm himself as early as 1882, our only course appears to be to credit Rehm with having been the first to make the combination, *Sclerotinia Duriaeana*.

Since Boudier does not specify the species of *Carex* from which his material came and concerns himself only with the apothecial stage, it is impossible to tell with certainty to which of the two forms, **affine** or **ambiens,** his specimens belonged, more probably to the latter.

The exsiccati specimens of European material of the apothecial stage which we have examined are here listed:

Affine form.

Rehm: Ascomyceten, *603 Sclerotinia Duriaeana* (Tul.) on *Carex stricta* Good. **C. U. Durand;** *603b Sclerotinia Duriaeana* (Tul.) on *Carex stricta* Good. **C. U. Durand.**

Rabenhorst-Winter: Fungi Europaei, *2749 Sclerotinia Duriaeana* (Tul.) on *Carex stricta* Good. **C. U. Durand.**

Ambiens form.

None.

Although, as we have pointed out in a previous article (Mycologia **18:** 233), apothecial characters are usually of little diag-

nostic value for separating species of *Sclerotinia;* nevertheless they must always be taken into consideration. When, however, we undertake to make a comparison of the available data on the apothecial structures of these two supposed forms, we find the information too scant to warrant the drawing of conclusions therefrom. The following measurements constitute all the available evidence we have from European sources on the apothecial stages.

Affine form.

Rehm: Hedwigia **21:** 66 on *C. stricta* Good., asci 140 × 8 μ, ascosp. 10–14 × 4–6 μ.

Rehm: Ascom. *603* on *C. stricta* Good., asci 133.5–182 × 7.8–9.1 μ, ascosp. 10.8–15 × 4.8–6 μ.[2]

Rabenhorst-Winter: Fung. Europ. *2749* on *C. stricta*, asci 127.5–170 × 7.8–11.7 μ, ascosp. 10.2–15 × 5.4–7.2 μ.[3]

Rehm: Ascom. *603b* on *C. stricta* Good., asci 146–164 × 7.3–9.1 μ, ascosp. 10.7–12.4 × 5.3–7.9 μ.[2]

Rehm: Rab. Krypt. Fl. **3:** 820 on *C. stricta* Good., asci 140–180 × 8–9 μ, ascosp. 12–18 × 5–9 μ.

Ambiens form.

Tulasne: Carp. **1:** 104 on *C. arenaria*, asci (80–95)[4] × 8–9.5 μ, ascosp. 10–15 × 6.5–7.5 μ.

Boudier: Icon. **4:** 274 on *Carex* sp.,[5] asci 210–230 × 7–15 μ, ascosp. 14–18 × 6–7 μ.

In spite of the marked similarity in size of asci and ascospores as indicated in the above measurements, there remain two features in which the **affine** and the **ambiens** forms differ. First and most striking is the form and distribution of the sporodochia which has already been pointed out and emphasized. There also appears to be a distinct difference in the sclerotia of the two forms. Judging from the abundant sclerotia in Tulasne's type material on *C. arenaria* and the few sclerotia present in the specimens on *C. paniculata* which we have seen, the sclerotia of

[2] Our measurements from dry material in KOH.

[3] Measurements made by us from same material on which Rehm presumably based his own measurements.

[4] Tulasne says, "asci about 10 times as long as broad"; may not have taken into account lower nonsporogenous part of ascus.

[5] Boudier does not specify species of *Carex* from which his material came, but probably it was *C. arenaria* or *C. paniculata.*

the **ambiens** form are distinctly more slender, being of nearly uniform diameter throughout their length. They are also more generally curved. They show little or no trace of striations, and are of a dark brown rather than jet black color (FIG. 8). The sclerotia of the **affine** form on the other hand are distinctly fusiform, being decidedly thicker at the center. While they vary markedly in length and thickness in the different host species, they are always relatively stout, *i.e.* thick for their length. They are jet black, finely striated and only slightly curved in the larger specimens, and even here the curving is more apparent than real (FIG. 7).

One appears then to have the choice of two interpretations of the situation presented above: either,

(1) The fungi commonly referred by European workers in the past to *S. Duriaeana* are one and the same species, the sporodochia varying strikingly on different species of *Carex;* or

(2) Two species of *Sclerotinia*, very similar in respect to sclerotia and apothecia but with strikingly different sporodochia, have been confused by European mycologists up to the present. The form occurring on *C. arenaria* and *C. paniculata* is the true *Peziza Duriaeana* of Tulasne, the other, an as yet unnamed species, occurring in Europe on *C. Hudsonii* Bennett, *C. gracilis* Curt., *C. vulpina* L. and possibly also on *Schoenus nigricans* L. as well as on several species of *Carex* in America.

It seems impossible to settle this question until we can collect and culture the forms on the different species of *Carex* in Europe. For the present we have chosen therefore to accept the first interpretation and to apply the name *S. Duriaeana* (Tul.) Rehm to both the **ambiens** and **affine** forms, though from the evidence now available to us we are inclined to believe that the second interpretation is the correct one. Should further researches confirm the occurrence of two distinct species, we would give to the **affine** form the name **Sclerotinia sulcata** (Desm.) **n. comb.** since the first species name applied to it was that of Roberge, used on sclerotial specimens and adopted by Desmazières in his description of *Sclerotium sulcatum*. The **ambiens** form, evidently that which Tulasne had in hand, should bear the name *Sclerotinia Duriaeana* (Tul.) Rehm.

THE AUTHOR'S STUDIES ON COLLECTIONS OF SCLEROTINIA DURIAEANA IN NORTH AMERICA

Specimens of *S. Duriaeana* were first taken by the writer in the McLean Swamp on April 26, 1921. Only a few were found at that time. They were scattered among those of our new species, *Sclerotinia longisclerotialis*, which were present in great abundance and which we were particularly seeking. The apothecia and sclerotia of *S. Duriaeana* (FIGS. 5 AND 6) are distinguished at once from those of *S. longisclerotialis* (FIG. 13) by the shorter stipes and broader cups as well as by the short, thick and pointed sclerotia. Apothecia of *S. Duriaeana* were taken in the same marsh on May 10, 1925, at which time they were again found in limited numbers. Observations during the summer of 1925 indicate that infection by the ascospores of this species is exceedingly common, in fact, very general, on its chief *Carex* hosts throughout the swamp.

Our American species of the *Sclerotinia Duriaeana* type undoubtedly belongs to the **affine** form as may be seen from the photographs (FIGS. 1 AND 2). Thus far nine species of *Carex* have been found to be hosts for it in North America. It occurs about Ithaca in abundance on *Carex stricta* Lam., a species closely related to one of its common European hosts, *C. Hudsonii* (*C. stricta* Good.). It also occurs to a considerable extent upon *Carex prairea*, which is at the same time the principal host for *S. longisclerotialis*.

We have discovered but one American collection of *S. Duriaeana* made earlier than our own. In August 1901, Griffiths and Morris collected the sclerotia and sporodochia of a fungus on *Carex nebraskensis* Dewey near Andrews, Oregon. Griffiths (1902) described it as *Claviceps? caricina* sp. nov., saying, "No one recognizes better than the writer that the placing of the species in the genus *Claviceps* is a wild guess." An examination of specimens from this collection, distributed under number *400* West American Fungi, shows it to be without doubt a *Sclerotinia* of the **affine** form. The sclerotia and sporodochia correspond in every way with these structures as we find them in the form on *Carex* species about Ithaca. Attempts to obtain living material on this host from Andrews, Oregon, for cultural studies have been in vain.

A collection of this species on *C. stricta* Lam. has recently been received from J. R. Schramm, collected by him near Wilson Station, Del. (**C. U. Pl. Path.** *17028*).

There is little doubt that this species is widely distributed throughout North America where *Carex* species abound. It will probably be found on many species of *Carex* in addition to those listed below.

LIFE HISTORY. Although no inoculation experiments have been conducted, field observations and studies of the fungus in pure culture indicate the main features of its life history.

The sclerotium, as it matures, causes the culm to crack open on one or more of its faces (FIG. 3). The culm, weakened at this point, breaks over and frees the sclerotium (FIG. 4C), which falls into the water below or among the growing culms of the host. Here it lies throughout the winter and early in the spring gives rise to the short, stout-stemmed apothecium (FIG. 5). Each sclerotium usually produces but one apothecium, rarely two. One may occasionally find an apothecium arising upon a sclerotium still enclosed in the old partially rotten culm (FIG. 6). However, the retention of the sclerotium in the culm until it falls over is apparently not common. The apothecia begin to open and discharge their ascospores as the young inflorescence of the host emerges from the upper leaf sheath. The first parts of the inflorescence of *C. stricta* to be exposed are the male spikes and observations seem to indicate that it is through these male spikes that invasion by the germ tubes of the ascospores occurs. There is much evidence that infection proceeds from the male flowers downward through the culm, which is usually killed entirely to the crown, though in a large number of cases infection seems to be halted one half or two thirds of the way to the base. It is possible that invasion may sometimes be through the female flowers but they usually appear to die because of the death of the culm to which they are attached. The actual method of invasion remains to be investigated and the carrying out of careful inoculation experiments for this purpose is highly desirable. No observations on the point of invasion in the other host species of *Carex* have been made.

The first evidence of infection is a withering and drying up of

the spikes followed by a progressive downward hydrosis of the culm. As the infection proceeds there is often a succession of color changes, especially in *C. stricta*, giving to the diseased portion a more or less banded appearance due to the alternating light and dark regions in the lesions (FIG. 1). The infected culms are eventually blanched, becoming straw colored or even white as is the case in *C. prairea* and *C. interior*.

In the upper part of the affected culm and especially just below the spikes, minute linear dark brown bodies, microconidial sporodochia, are formed in considerable numbers (FIGS. 1 AND 2). They begin to appear shortly after infection becomes evident. The minute microconidia ooze out in a watery mass from slits in the cuticle over the sporodochia. No attempts to germinate the microconidia of this species have been made by the writer. Although Brefeld (1891: 316–317) failed to obtain germination of the microconidia of *S. Duriaeana* and of other related species, it seems possible from the work of Ferdinandsen and Winge (1911: 297) on *S. scirpicola* that the microconidia may germinate and produce secondary infection during the summer. They more probably function as do the spermatia of the rusts (Craigie, 1927).

Formation of sclerotia in this species begins relatively early in the summer as they are to be found in large numbers even in June. They usually develop at or below the middle of the culm. There is in general but one sclerotium per culm though two and even three are not infrequent.

The culms break over, freeing the sclerotia as already described. The apothecia appear in April and May of the following year and are usually most abundant in late April or early May, depending of course upon the season which correlates their development with the development of the inflorescences of the different hosts.

CULTURAL CHARACTERS. Grown on the following standard media,[6] potato agar, oat agar and nutrient agar, this species exhibits the following characteristics: Sclerotia and microconidia only are produced. The sclerotia mature in about 20 days upon potato agar, especially in test tube slants though occasion-

[6] For method of preparing these media see Mycologia **18**: 230.

ally in petri dishes (FIGS. 17 AND 18). They are large, black when mature, more or less loaf-shape, and usually form against the glass at the base of the slant (FIGS. 14 AND 15). The interior, showing where the surface adheres to the glass, is of a light pink color, which at once distinguishes this species in culture. On potato agar in petri dishes or slants there is an abundant development of white cottony aërial mycelium (FIG. 16), becoming brownish gray with age. Microconidial sporodochia of a dark brown to black color are formed about the margin of old cultures (FIGS. 18 AND 19). Brefeld (1891: 316) reports this abundant production of white aërial mycelium and microconidia in his cultures from ascospores of *S. Duriaeana*. Growth on oat agar is less vigorous. Growth on nutrient agar is very poor with scarcely any aërial mycelium. This medium becomes slightly but distinctly reddish brown under the colony; no sclerotia formed.

This species is readily distinguished in culture from *S. longisclerotialis* by its dense cottony growth of aërial mycelium and by the development on potato agar of large loaf-shaped sclerotia which are pink within. (Compare FIGURES 16 AND 20 AND 14 AND 22. No sclerotia of *S. longisclerotialis* have been obtained in culture.) The submerged mycelium of *S. Duriaeana* in potato agar turns a dirty brown with age while that of *S. longisclerotialis* darkens but little or not at all in this medium.

DESCRIPTION OF SCLEROTINIA DURIAEANA[7] (**affine form**)

The sporodochia (FIG. 2) are scattered, *i.e.* not occurring in groups at regularly spaced intervals along the culm; usually confined to the upper part of the culm above the first sclerotium, but sometimes sparsely produced below, between sclerotia; almost always confined to two faces of the 3-sided culm; distinctly linear, 2–5 mm. long by $\frac{1}{3}$–$\frac{1}{2}$ mm. broad; dull olivaceous brown, inconspicuous, opening by a longitudinal slit when mature, from which ooze the masses of microconidia. These sporodochia lie imbedded in the tissues between the vascular bundles just

[7] Although Tulasne (1861: 103–105) gives an excellent and detailed description of the species, it seems desirable to present here a brief diagnosis based upon our studies of American material, especially since the American form as already pointed out may prove to be distinct from *S. Duriaeana* of Tulasne.

beneath the epidermis of the culm. They consist of numerous dense masses of microconidia cut off in chains from the Indian-club-shaped conidiophores which arise in fascicles from a single cell of the mycelium. Each sporodochial fruit body is thus compounded of numerous fasciculate globose masses of conidiophores which appear in cross section as star-like centers isolated in the mass of microconidia (Tul. Carp. **3:** Pl. 22, Fig. 21). The structure of the sporodochial masses in this species is essentially like that of the sporodochia of *S. longisclerotialis* (FIG. 23). The cavities in which they lie have been formed by the dissolution of the parenchymatous tissues of the culm. The vascular bundles and the epidermis remain apparently unaffected except for the rupture of the latter to afford escape for the microconidia. The microconidia are globose, about 2 μ in diameter, hyaline; produced, probably as in *Botrytis* (Brierley, 1918: 133–134), each conidiophore giving rise to a large number of microconidia.

Sclerotia, one to three in each culm; when mature, exposed by the rupture of the epidermis along one or two faces of the culm, which thus weakened soon breaks over, widening the slit and allowing the sclerotium to fall; black, fusiform, much resembling the ergots of *Claviceps*, often inequilateral or slightly curved in the larger specimens. These sclerotia originate as loose cottony, white, hyphal masses in the interior of the culm. Each mass gradually thickens, becoming a compact, firm fusiform body of a beautiful pale pink color. As it matures and ripens, this color changes to a smoky gray and finally black. The pointed or rounded ends of the black sclerotium are each capped for a time by a white hyphal weft continuous with the mycelium in the tissues (FIG. 4a). The sclerotia vary greatly in size, according to the slenderness of the host culm in which they are formed. The largest we have seen are those produced in culms of *C. riparia* var. *lacustris*, which are usually 20–25 mm. long by 3–4 mm. thick and strongly 3-angled. The smallest are those formed in the very slender culms of *C. interior*. These are short truncate averaging 4–5 × 1½–2 mm. Those in *C. stricta* are usually more fusiform pointed, averaging 6–8 × 2–2½ mm. (FIG. 4C). The sclerotia are in all hosts more or less 3-angled, the angles rounded and the surface striate due to the pressure of the vascular

bundles on the sclerotium while developing in the culm. The mature sclerotium shows in cross-section a white medulla surrounded by a thin black rind (TEXT FIG. 1).

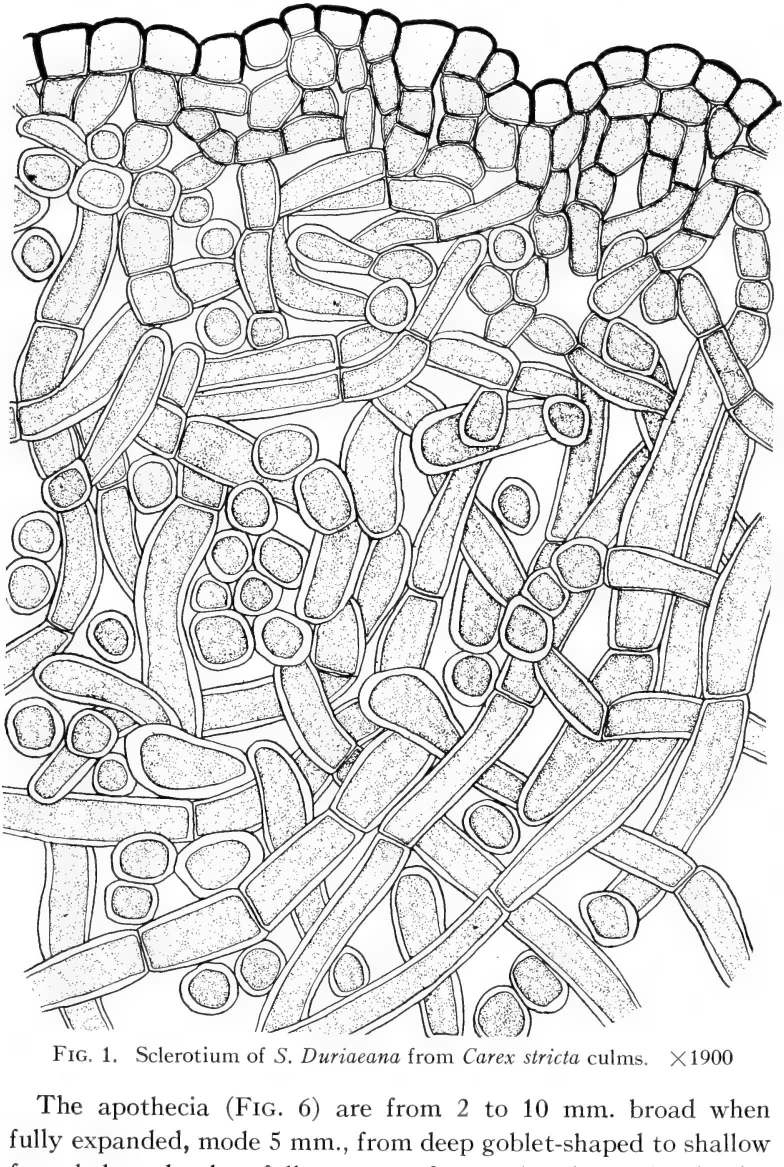

FIG. 1. Sclerotium of *S. Duriaeana* from *Carex stricta* culms. ×1900

The apothecia (FIG. 6) are from 2 to 10 mm. broad when fully expanded, mode 5 mm., from deep goblet-shaped to shallow funnel-shaped, when fully mature, fawn colored, varying in size

with the sclerotium from which they arise; stipe rather short, 5–20 mm. long, darker below. Paraphyses slender, slightly swollen, long clavate at apex, hyaline.

Asci 8-spored, slender, blunt at apex, slightly attenuated below; 106 measurements from 6 apothecia from *C. stricta* give a variation of 128–183 × 7.3–11 μ, averaging 161 × 8.6 μ with a mode of 155.8 × 9.16 μ.

Ascospores hyaline, uniseriate, long ovate, often inequilateral; 205 measurements from 5 apothecia from *C. stricta* give a variation of 8.8–17.5 × 5.3–8.8 μ, averaging 12.6 × 6.9 μ with a mode of 13.1 × 7.09 μ. The ascospores allowed to discharge on the surface of potato agar germinate readily and form a dense cottony growth (FIG. 16) of limited extent, showing no tendency to feathery rhizomorphic strands as in *S. longisclerotialis* (FIG. 20).

Found in wet open *Carex* swamps. In North America, most common and abundant on *Carex stricta* Lam.;[8] occurring also on *C. prairea* Dewey, *C. interior* Bailey, *C. hystericina* Muhle., *C. riparia* Curt. var. *lacustris* (Willd.) Küken, *C. flava* L., *C. rostrata* Stokes, and *C. crinita* Lam., in the vicinity of Ithaca and McLean, N. Y. It is also known on *C. nebraskensis* Dewey from Andrews, Oregon.

In Europe, the **affine** form is recorded on *C. Hudsonii* Bennett (*C. stricta* Good.), *C. vulpina* L. and *C. gracilis* Curt. (*C. acuta* L.).

HERBARIUM MATERIAL.—The herbarium specimens here listed are North American collections only. The European specimens which the writer has examined are listed on p. 10–11. Unless otherwise indicated the numbers refer to specimens collected about Ithaca and deposited in the herbarium of the Department of Plant Pathology, of Cornell University.

On *C. stricta*, (apoth.) *11515* **type,** *14148, 14184, 15146;* (sclerot.) *14747;* (sporod.) *15810, 15813, 15816, 15187, 15883;* (sclerot. and sporod.) *17044* (Delaware).

C. prairea, (apoth.) *15160;* (sclerot.) *14947, 15809, 15873;* (sporod.) *15811, 15812, 15815, 15821.*

[8] All host species have been determined by K. M. Wiegand of the Botanical Department of Cornell University. The nomenclature followed is that used in the Flora of the Cayuga Lake Basin, New York. Cornell University Agr. Exp. Sta. Mem. 92. 1925.

C. interior, (sclerot.) *15867;* (sporod.) *15814, 15820.*
C. riparia, (apoth.) *15627;* (sclerot.) *15176.*
C. hystericina, (sclerot. and sporod.) *15009, 15818.*
C. crinita, (sclerot. and sporod.) *15795.*
C. rostrata, (sclerot. and sporod.) *15884.*
C. flava, (sclerot. and sporod.) *15865.*
C. Nebraskensis, (sclerot. and sporod.) West Amer. Fung. *400* (Oregon).

Duplicates from our collections have been deposited in the herbaria of Harvard University; New York Botanical Garden; Mycological Collections, Bur. Pl. Ind. U. S. Dept. Agr.; University of Wisconsin; Kew Gardens, England; and Muséum d'Histoire Naturelle, Paris, as follows: Nos. *15146, 15816, 15160, 15873.*

NOTES

We have seen but two specimens from North America heretofore definitely referred to *S. Duriaeana.* One was collected by Clements (Webber, 1892: 47) in the woods at Lincoln, Nebraska, Apr. 27, 1892. This specimen was determined by Clements. Examination of this material (in the Durand collection, Cornell University) shows several small apothecia arising from a large loaf-shaped sclerotium apparently buried in the soil. While measurements of asci and ascospores of this material show them to approximate the size and shape of these structures in our material of *S. Duriaeana*, the character of the sclerotium and its habitat would seem to invalidate Clements' reference of it to this species.

The other specimen was one collected by Vahl in 1829 near Nonnese, Greenland. The host is given as *Carex rigida* Good. The fungus was determined by Rostrup as "*S. Duriaeana* Tul." and is in the Rostrup collection now deposited in the Botanical Museum of the University of Copenhagen. Through the kindness of the curator of the museum we have been able to examine this specimen. It consists of a group of 3 large triangularly conical, pointed sclerotia evidently formed at the base of the leaves of a stunted culm. A single long stalked apothecium arises from the base of one of these sclerotia. On comparing this specimen with specimens of *S. Vahliana* Rostrup, No. *730*

in Vestergren, Mycomycetes variores selecti, on *Eriophorum angustifolium* (**Myc. Coll. U. S. D. A.**) and with another specimen of the same fungus on *Eriophorum polystachium* distributed by Nannfeldt in Fungi Suecici (**N. Y. B. G. Herb.**), both collected in Arctic Scandinavia, it seems certain that the Greenland specimen is *S. Vahliana* rather than *S. Duriaeana* and that the host of Vahl's specimen is an Eriophorum rather than a Carex.

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SCLEROTINIA LONGISCLEROTIALIS

This was the first species of *Sclerotinia* on *Carex* collected by the writer. Walking through an open *Carex* swamp near McLean, N. Y., on May 16, 1918, in company with several colleagues, we were astonished to discover large numbers of small goblet-shaped apothecia protruding from the water in the shallow pools among the *Carex* hummocks. When we began to collect them it was discovered that they arose from long slender black sclerotia lying in the debris at the bottom of the pools or hidden in the wet sphagnum moss on the sides of the hummocks. It soon became evident that they had been formed in last year's culms of some species of *Carex*, several of which were abundant

here and at this time showing well exposed new inflorescences. It was not possible to determine at the time with certainty just which species was the host of this *Sclerotinia*. Photographs of the apothecia attached to sclerotia (FIG. 13) and cultures from ascospores (FIG. 20) were obtained. Subsequent collections of the apothecia have been made in this same swamp nearly every spring, during the latter part of April or some time during May.

During the summers of 1925, 1926 and 1927 the swamp was visited on several occasions in June, July, August, September and October to follow the development of infections which are always abundant there by mid-June on several species of *Carex*. It was important to determine first which species were the hosts of this *Sclerotinia* and which were hosts of *S. Duriaeana*.

Carex prairea Dewey was from the first suspected to be the chief host of *S. longisclerotialis*. As the summer advanced, the short stout fusiform sclerotia of *S. Duriaeana* appeared in abundance in the diseased culms of *Carex stricta* and also here and there in those of *Carex prairea*. By mid-July the sclerotia of this species were common and maturing, but not a sclerotium of *S. longisclerotialis* was discovered until Aug. 22, when, running a diseased culm of *C. prairea* between the thumb and finger, the firm, young sclerotia, as yet for the most part completely enclosed, were readily detected. On opening the culms the sclerotia were found to be just taking on the dark color. A few culms showed a long slit on one face near one of the angles of the 3-sided culm through which the black sclerotium was visible (FIG. 12). By September many of the sclerotia were apparently nearly mature and partially exposed by the slit in the culm. Even in early October most of them were still enclosed in the culms which were now falling over, bending not at the sclerotium as in *S. Duriaeana* but usually at the base.

Infected culms of *C. prairea* were collected on June 19 and again on July 3, 1925, from which tissue plantings were made. Most of these gave cultures typical of those obtained from ascospore shootings of *S. longisclerotialis* though occasional plantings gave cultures characteristic of *S. Duriaeana*. Plantings made later from the long slender sclerotia gave cultures like those obtained from ascospore shootings of *S. longisclerotialis*.

While collecting diseased culms of *Carex prairea* during June and July, it was observed that the very slender culms of *Carex interior* Bailey showed infections and black sporodochial bodies (FIG. 11) similar to those in the former host species. Tissue plantings from these culms gave typical cultures of *S. longisclerotialis* but no sclerotia were discovered in the culms of this host until September 4, 1927. They were then just beginning to color and were still completely enclosed in the culms except for an occasional one which showed the rupture slit. While collecting at Pleasant Lake, Maine, on August 25, 1927, *S. longisclerotialis* was taken on *C. interior* and three other species, *C. vesicaria*, *C. retrorsa*, and *C. crinita*. The last three hosts all showed sporodochia and sclerotia. The sclerotia were still firmly enclosed and had scarcely begun to turn black. It is thus clear that *S. longisclerotialis* begins formation of sclerotia later in the season than does *S. Duriaeana* and does not mature them until late summer or autumn instead of mid-summer. Apothecial formation and infection also appear to occur somewhat later in the spring. Apothecia of both species have been taken on the same day as early as April 26 and as late as May 24 but the peak for apothecial production appears to be at least a week or more earlier for *S. Duriaeana* than for *S. longisclerotialis*.

LIFE HISTORY.—The life history of *Sclerotinia longisclerotialis* as here presented is based upon field observations and studies of the fungus in pure culture. No infection experiments have been made.

The sclerotia mature within the culms of the host during late August and September. Although the culms may crack open, exposing the sclerotia, many, if not most, of the sclerotia remain in place until after the culms fall over. They are to some extent freed during the winter and spring by the partial disintegration of the enclosing tissues of the host. Many of them are to be found still enclosed in the rotting culms at the time of apothecial production (FIG. 13). During late April and May of the year following their formation, the sclerotia give rise to the apothecia, which mature shortly after the inflorescence of the host emerges from the upper leaf sheath. The apothecia are found in greatest abundance in the bottom of the pools about the hummocks of

their hosts, though some are always to be found in the wet sphagnum or decaying leaves on the sides of the hummocks. The long-stiped apothecia lifting their goblet-shaped cups above the water present a striking and exciting picture for the collector.

The ascospores are shot into the air and, falling on the young flowers of the host, germinate and cause infection. Through what organs of the flower the germ tubes gain entrance was not determined. Infection must occur early in the development of the inflorescence as it is killed while the spikes are still crowded on the axis. In the case of *C. prairea* at least, the axis of healthy heads rapidly elongates, separating the spikes. Affected inflorescences present an erect, compact aspect in contrast to the slender drooping form of the healthy heads (FIG. 10). The infected inflorescence turns brown and dies. The bracts and flowers persist until well into autumn. In diseased plants of *C. interior*, however, the female flowers quickly fall away. The infection spreads downward through the culm, which loses its green color and exhibits broad bands of alternating light and dark brown shades (FIG. 10).

At rather uniform distances along the upper part of the diseased culm just below the inflorescence there soon appear groups of the short black sporodochia (FIGS. 11 AND 12), containing the microconidia, the role of which in the life history of the fungus is problematical as has been pointed out in the case of *S. Duriaeana*. No attempts to germinate the microconidia of this species have been made.

Sclerotial production begins sometime in late July or early August, usually about midway of the diseased culm. There is usually but one sclerotium per culm though two or even three are not uncommon. The ripe sclerotia fall to the ground, for the most part still enclosed in the culms, there to lie in the water or among the rotting culms in the hummocks until the following spring when they germinate, producing apothecia as already described.

CULTURAL CHARACTERS.—Ascospore sowings on potato agar germinate promptly, giving a characteristic and rapid growth. A white rhizomorphic growth of appressed feathery, aërial mycelium rapidly covers the surface of the media (FIG. 20). The

rhizomorphic feathery habit is often not so evident on potato agar test tube slants, becoming after a time more dense and felty but never showing the cottony masses so characteristic of *S. Duriaeana*. On oat agar, growth is sparse and the white aërial mycelium is thin and webby. Growth on nutrient agar is similar to that on oat agar, the media taking on a dirty reddish brown tint. The submerged mycelium darkens but little or not at all with age on potato agar.

Sclerotia have never been obtained in culture on any media. Black microconidial crusts are sometimes formed with age along the margin of the slant in potato agar in test tubes (FIGS. 21 AND 22). Microconidial masses also sometimes appear in old petri dish cultures on potato agar.

DESCRIPTION OF **Sclerotinia longisclerotialis** N. SP.

The sporodochia are formed in groups at rather regularly spaced intervals along the culm; most abundant and prominent just below the spikes, sometimes present also below the sclerotium toward the base of the culm; usually confined to two faces of the 3-angled culm; short, shining black, ovate oblong, opening by a slit from which ooze the masses of microconidia. Microconidia globose, 1–2 μ in diameter, produced successively from clustered Indian-club-shaped conidiophores. The internal structure of these sporodochia corresponds to that in *S. Duriaeana* and is clearly indicated in the cross section sketch (FIG. 23). In external appearance and arrangement the sporodochia of *S. longisclerotialis* are strikingly different from those of the American form of *S. Duriaeana*. (Compare FIGS. 11 AND 12 with FIG. 2.) They are almost identical in appearance with those of the **ambiens** form of *S. Duriaeana* as described and figured by Tulasne (Carp. **3**: pl. 22, fig. 20). (Compare FIGS. 11 AND 12 with FIG. 9.)

Sclerotia usually one or two, sometimes three in each culm; remaining enclosed even at maturity, not discharged by breaking over of the culm as in the case of *S. Duriaeana;* somewhat exposed by a narrow slit in the epidermis; at maturity black, oblong, truncate, uniform in thickness, more or less 3-angled; striate due to the pressure of the vascular strands of the culm during

development. They originate as loose cottony wefts of white mycelial hyphae in the interior of the culm. These gradually thicken, forming a firm body at first of a pinkish color gradually changing to a smoky gray color on the exterior, finally black. The truncate ends are each capped by a long pointed weft of white mycelium continuous with the mycelium in the tissues of the culm. This disappears after the sclerotium inclosed in the culm falls into the water. Mature sclerotia vary in size with the slenderness of the host culm, ranging from 1 cm. long by 1 mm. thick in culms of *C. interior* to 7 cm. long by 2 mm. thick in culms of *C. retrorsa;* in cross section showing a loose central hyphal medulla surrounded by a densely woven very narrow white medullar zone, the hyphae of which run more or less parallel with the long axis of the sclerotium. The black rind consists of a very thin one-celled layer of pseudoparenchyma supported by the dense outer medullar zone of hyphae.

Apothecia 2 to 5 mm. broad, goblet-shaped, with slender stipes 15–30 mm. long; mouth constricted, never becoming widely open or reflexed expanded (FIG. 13). The cup is of a dark fawn color, the stipe paler and smooth above, below dark tomentose, arising from the long slender sclerotium. Usually but one apothecium from each sclerotium, rarely two to three.

Paraphyses simple, very slender, slightly clavate, septate.

Asci long cylindric, attenuate below the middle; 136 measurements from 5 apothecia from *C. prairea* gave a variation of 170–230 $\times$ 8.8–14.3 μ, averaging 182.1 $\times$ 10.7 μ with a mode of 194 $\times$ 10.4 μ.

Ascospores strongly inequilateral, flat or incurved on one side; 289 measurements from 5 apothecia from *C. prairea* gave a variation of 12.6–22.8 $\times$ 5.3–12.5 μ, averaging 18.3 $\times$ 8.1 μ with a mode of 21 $\times$ 9 μ.

The ascospores allowed to discharge on the surface of the media germinate and grow readily on potato agar, forming a white, more or less appressed feathery mat of mycelium. No sclerotia are produced. Microconidia are abundantly produced on the mycelium in old cultures, forming minute, hard masses, especially on the glass along the edge of potato agar slants (FIGS. 21 AND 22).

Found in open *Carex* swamps, often in association with *S. Duriaeana*. Most common and abundant on *Carex prairea* Dewey; occurs also on *C. interior* Bailey, *C. crinita* Lam., *C. vesicaria* L., and *C. retrorsa* Schw. Known only from the vicinity of McLean, N. Y., and Pleasant Lake, Maine.

HERBARIUM MATERIAL.—All numbers refer to specimens deposited in the herbarium of the Department of Plant Pathology, Cornell University, and, unless otherwise indicated, collected about McLean, N. Y.

On *C. prairea*, (apoth.) *10544* **type**, *11516*, *14179*, *15149*, *15161*, *15162;* (sclerot.) *14946*, *15824*, *15872;* (sporod.) *14748*, *15823*, *15825*.

C. interior, (sclerot.) *15868;* (sporod.) *14753*, *15822*, *15859* (Maine).

C. vesicaria (sporod. and sclerot.) *15860* (Maine).

C. retrorsa, (sporod. and sclerot.) *15059* (Maine).

C. crinita, (sporod. and sclerot.) *15858* (Maine).

Duplicates from our collections have been deposited in the herbaria of Harvard University; New York Botanical Garden; Mycological Collections, Bur. Pl. Ind. U. S. Dept. Agr.; University of Wisconsin; Kew Gardens, England, and Muséum d'Histoire Naturelle, Paris, as follows: *15161*, *14179*, *14946*, *14753*.

NOTES.—We have found no description of a *Sclerotinia* on *Carex* approaching our species, especially in the form of its sclerotium. Its asci and ascospores are both much larger than those of *S. Duriaeana* from which it is clearly separated also by the form of its sclerotium. While it has been collected only in two widely separated localities, it will probably be found throughout northeastern United States and Canada where its hosts occur. It is well worth getting one's feet wet just for the joy of finding and admiring this beautiful and interesting species.

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PLATE 2

Morphology of *Sclerotinia Duriaeana*

Fig. 1. Aspect of infected plants of *Carex stricta* as they appear toward end of June. Inflorescence killed at time of flowering. Healthy plant at left. Nat. size. C. U. Pl. Path. Herb. *14747*.

Fig. 2. Microconidial sporodochia in upper part of culms of *C. stricta*. 2 × nat. size. C. U. Pl. Path. Herb. *14747*.

Fig. 3. Sclerotia in culms of *C. prairea* in different stages of development, early in July. 2 × nat. size. C. U. Pl. Path. Herb. *14947*.

Fig. 4. Nearly mature sclerotia from culms of *C. stricta; a* and *b*, showing appendage-like wefts of white mycelium at the end of the sclerotium which disappear with maturity of the sclerotium; *c* and *d*, mature sclerotium being discharged from the culm; *e*, sclerotium breaking in attempt to free itself from the culm. 2 × nat. size. C. U. Pl. Path. Herb. *14747*.

PLATE 3

Morphology of *Sclerotinia Duriaeana*

Fig. 5. Young apothecia from sclerotia produced the previous season in culms of *C. stricta*. Nat. size. C. U. Pl. Path. Herb. *15146*.

Fig. 6. Fully developed apothecia; upper row from sclerotia in culms of *C. stricta;* lower row from sclerotia in culms of *C. prairea*. Nat. size. C. U. Pl. Path. Herb. *11515*.

Fig. 7. Sclerotia removed from culms of *C. prairea*. Nat. size. C. U. Pl. Path. Herb. *15873*. Compare as to size and shape with sclerotia in Fig. 8.

Fig. 8. Sclerotia from Tulasne's type material of *S. Duriaeana* in culms of *C. arenaria*, a species having culms of about the same size as *C. prairea*. Note that they are more slender than those of the American form (Fig. 7). Nat. size. C. U. Pl. Path. Herb. *17044*.

Fig. 9. Sporodochia and sclerotium in culm of *C. paniculata*, from specimen in de Thümen's Mycoth. Univ., No. *1575*, distributed under the name *Epidochium ambiens* Desm. Nat. size. C. U. Pl. Path. Herb. *15912*.

PLATE 4

Morphology and Cultural Characters of *Sclerotinia longisclerotialis* Whetzel

Fig. 10. Aspect of infected plants of *Carex prairea;* two heads at left alive and healthy, four at right killed at blossoming time. Taken June 19, 1925. Note color banding of culms at right. Nat. size. C. U. Pl. Path. Herb. *14748*.

Fig. 11. Aspect of infected plants of *Carex interior;* three heads at right healthy, others killed at blossoming time. Taken July 3, 1925. Note microconidial sporodochia in diseased culms. Nat. size. C. U. Pl. Path. Herb. *14753*.

Fig. 12. Sclerotia in culms of *Carex prairea;* three exposed by splitting the culms. Note striate markings. Microconidial sporodochia in culm at left. Taken Sept. 1, 1925. Nat. size. C. U. Pl. Path. Herb. *14946*.

Fig. 13. Apothecia arising from long truncate sclerotia in the water of the swamp. At right sclerotia still enclosed in the old culms. Nat. size. C. U. Pl. Path. Herb. *11516* and *10544*.

PLATE 5

Cultural Characters of *S. Duriaeana* and *S. longisclerotialis*

Fig. 14. Sclerotia of *S. Duriaeana* formed on potato agar. Culture 6 weeks old. Surface of sclerotium next the glass, pink. From culms of *Carex prairea*. Half nat. size. C. U. Pl. Path. Herb. *14947*.

Fig. 15. Sclerotia of *S. Duriaeana* formed on potato agar. Culture 6 weeks old; from culms of *Carex stricta*. Half nat. size. C. U. Pl. Path. Herb. *14747*.

Fig. 16. Typical growth of *S. Duriaeana* from *C. stricta* on potato agar; single ascospore plantings; 13-day-old culture. Half nat. size. C. U. Pl. Path. Herb. *11515*.

Fig. 17. Culture of *S. Duriaeana* from *C. stricta;* mycelial transfer on potato agar; about 6 weeks old. Note the large black sclerotia; also the microconidial masses forming at margins of the colonies. Colony at upper right of plate contaminated by bacteria. Half nat. size. C. U. Pl. Path. Herb. *14747*.

Fig. 18. Original culture of *S. Duriaeana* from bits of diseased culm of *C. stricta* disinfected and planted in potato agar. Photographed by transmitted light. Note the short dark bits of culms and the large sclerotia; also the microconidial masses fringing the margins of the colonies. Half nat. size. C. U. Pl. Path. Herb. *14747*.

Fig. 19. Fifteen-day-old culture of ascospore sowings of *S. Duriaeana* from *C. stricta* on potato agar. Note the microconidial masses. Half nat. size. C. U. Pl. Path. Herb. *11515*.

Fig. 20. Culture of *S. longisclerotialis* from *Carex prairea;* ascospore sowings on potato agar, 13 days old. Typical growth on this media. Half nat. size. C. U. Pl. Path. Herb. *11516*.

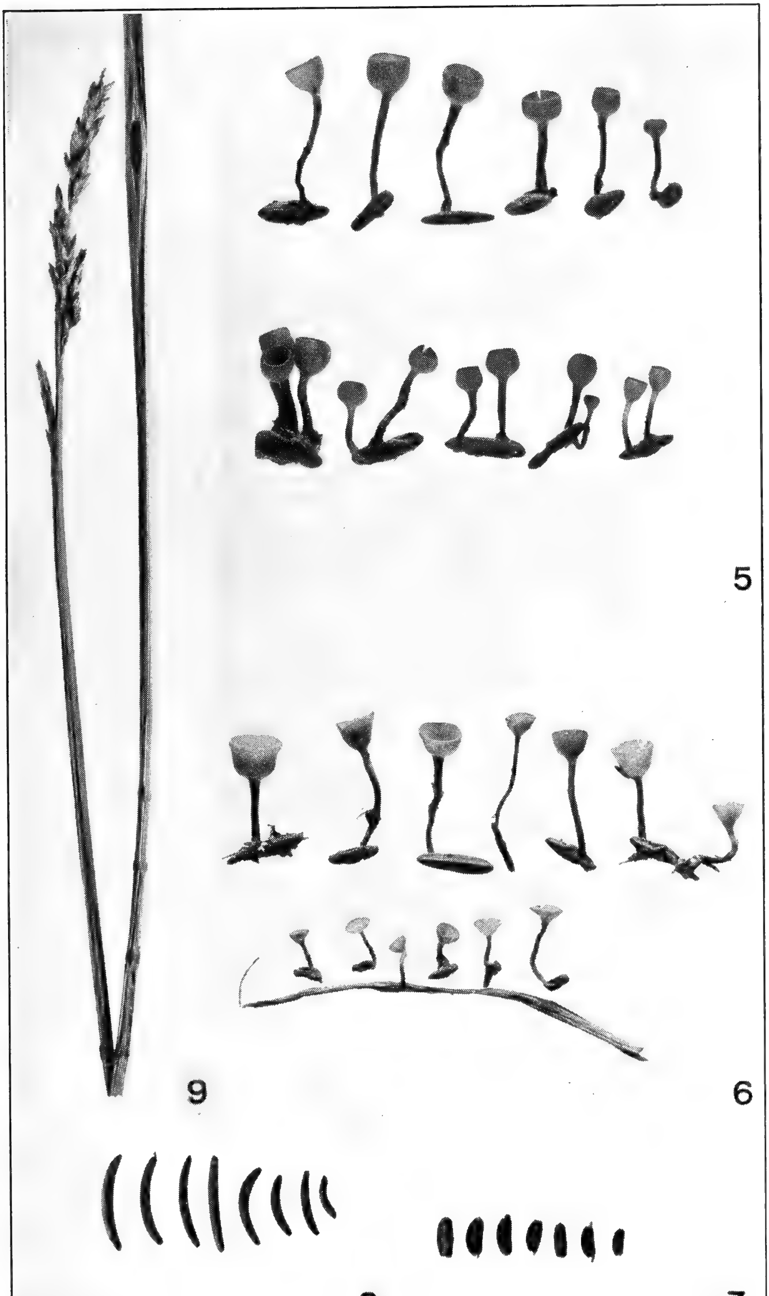
Fig. 21. Culture of *S. longisclerotialis* from *Carex prairea;* ascospore sowing on potato agar. Note absence of sclerotia and abundance of microconidial masses along margin of the slant. Half nat. size. C. U. Pl. Path. Herb. *14179*.

Fig. 22. Potato agar culture of *S. longisclerotialis* from *Carex prairea* showing formation of microconidial masses along margin of slant. Half nat. size. C. U. Pl. Path. Herb. *17046*.

PLATE 6

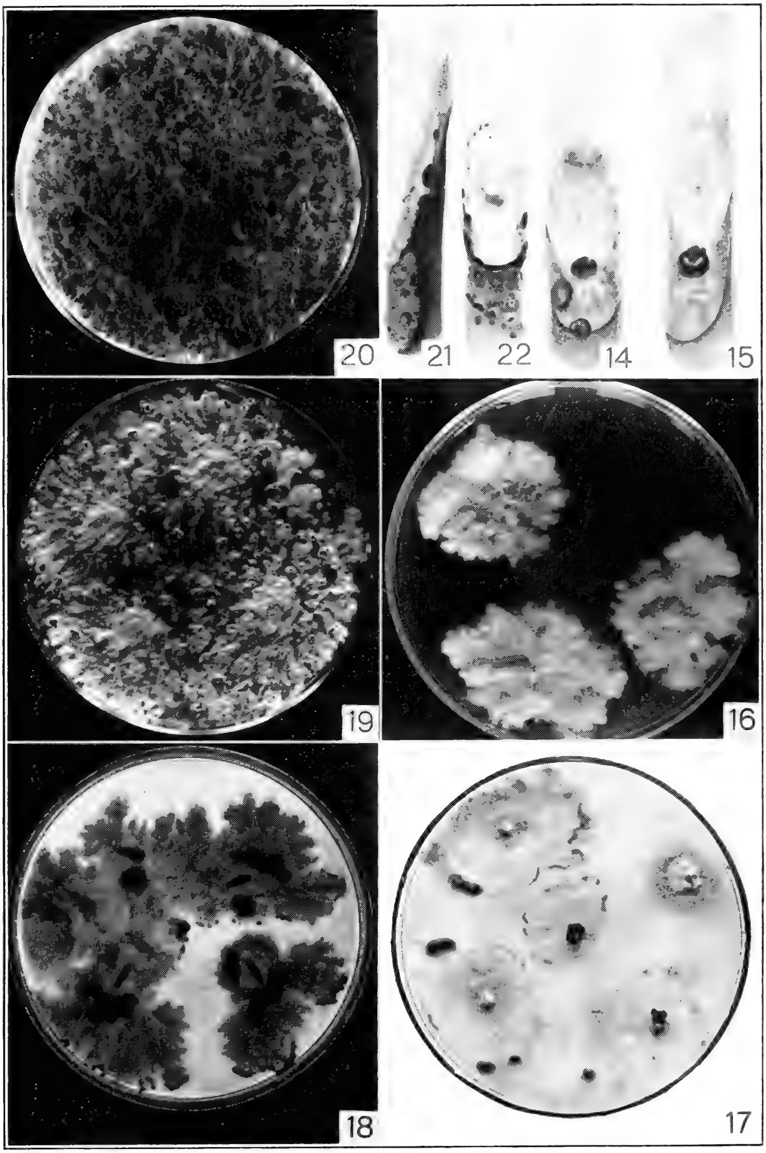
Fig. 23. Cross-section through sporodochium of *S. longisclerotialis* in culm of *Carex prairea*. Camera lucida drawing; about $\times$ 340. C. U. Pl. Path. Herb. *14946*.

Sclerotinia



Sclerotinia

SCLEROTINIA



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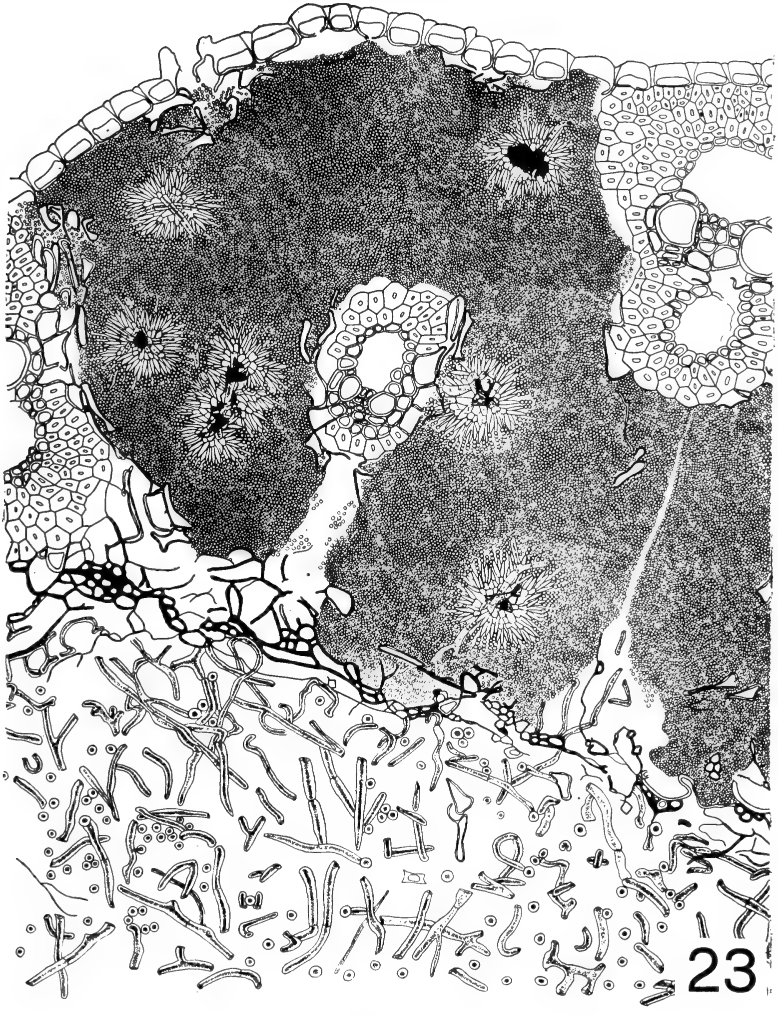

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SCLEROTINIA

NEW SPECIES OF LICHENS FROM PORTO RICO. II [1]

E. A. Vainio

[As stated in the previous paper 52 specimens of the Portorican lichens were submitted to Doctor Vainio for study. The new species described below are the result of his work on these specimens. The types are in Doctor Vainio's herbarium.]

1. **Lecanora chlorophaeiza** Vainio (n. sp.).

Sporis tenuioribus, disco apotheciorum testaceo-rufescenti et margine tenuiore a *L. chlorophaeode* Nyl. differt. Sporae long. 10–12, crass. 4–4.5 μ. Saxicola.

On rocks in an open field near Aibonito at 2200 ft., Fink *1939*.

2. **Pertusaria mastocheila** Vainio (n. sp.).

Thallus extus intusque KHO lutescens vel subfulvescens, verruculis minutissimis inspersus albidus. Pseudostromata albida, sat crebra, simplicia aut fortuito 2 confluentia, lat. 0.6–8 mm, nonnullis gibbis lateralibus instructa basi, constricta, vertice leviter impresso, sed disco nigricante saepe demum gibbum leviter prominentem formante, KHO extus parum reagentia, intus fulvescentia et demum partim leviter subrubescentia. Corticola.

On bark in an open field near Naranjito, Fink *218*.

3. **Buellia yaucoënsis** Vainio (n. sp.).

Thallus albido-glaucescens, nec KHO nec $CaCl_2O_2$ reagens, sat tenuis, laevigatus aut leviter verruculoso-inaequalis, hypothallo indistincto. Apothecia sat crebra, lat. 0.5–0.3 mm, disco demum convexo, nigro, nudo, opaco, margine nigro, tenuissimo, demum excluso. Epithecium fuscescens. Paraphyses sat laxe cohaerentes, apice anguste clavatae. Hypothecium sordide pallidum, partim dilute fuscescens, inferne sordide diluteque rubescens, hyphis erectis. Perithecium gonidiis destitutum, extus fuscescens, intus sordide pallidum. Sporae 8:nae, ellip-

[1] Number 1 of this series was published by Professor Bruce Fink in Mycologia **19:** 206–221. The present was transmitted through the Botany Department of Miami University, Oxford, Ohio, by Joyce Hedrick.

soideae oblongaeve, apicibus rotundatis, rectae aut rarius curvatae, septo sat tenui, membrana aequaliter modice incrassata, long. 10–16, crass. 5–7 μ, fuscescentes. Lignicola.

On old logs on an exposed hilltop near Yauco, Fink *1460*.

4. **Collemopsidium atlanticum** Vainio (n. sp.).

Thallus tenuis, partim subcontinuus, partim dispersus, sat laevigatus, fusco-nigricans, opacus, in lamina tenui fulvo-fuscescens. Apothecia circ. 0.15–0.2 mm lata, verrucas nigras formantia, disco punctiformi, nigro, saepe concavo vel leviter impresso, margine tenuissimo, nigro. Perithecium fusco-fuligineum, integrum, gonidiis destitutum. Hypothecium parte superiore fuscescens. Hymenium 80–90 μ crassum. Epithecium decoloratum pallidumve. Paraphyses arcte cohaerentes. Asci clavati aut subventricosi. Sporae 8:nae, distichae, decolores, ovoideo-oblongae, 1-septatae, haud constrictae, long. 15–17, crass. 5 μ. Gonidia gloeocapsoidea, cavitate rotundata, diam. 10–8 μ. Calcicola.

On rocks on an exposed hilltop near Yauco, Fink *1402* (type).

5. **Finkia portoricensis** Vainio (n. gen. et n. sp.).

Thallus crustaceus, sat tenuis aut modice incrassatus, rimosus vel diffractus, sat laevigatus aut leviter inaequalis, pallidus vel cinereo-pallescens, KHO non reagens. Apothecia demum prominentia, gyalectoidea, lat. 0.2 mm, disco testaceo rufescenteve, impresso, margine prominente, concolore aut raro fuscescente. Perithecium extus testaceum rufescensve, intus pallidum, gonidiis destitutum, plectenparenchymaticum, membranis sat tenuibus, conglutinatis, cavitatibus parvis. Hypothecium decoloratum. Epithecium decoloratum. Hymenium iodo non reagens (exsiccatum rubescens). Paraphyses gelatinosae, cavitatibus 1 μ latis. Sporae 8:nae-binae, decolores, oblongae ellipsoideaeve, murali-divisae, long. 24–27, crass. 12 μ. Gonidia gloeocapsoidea, globosa aut subglobosa, diam. 10–7 μ, membrana decolore, modice incrassata, chromatophoro glaucescente aut raro aeruginoso-virescente. Saxicola.—Gen. *Finkia* thallo crustaceo, gonidiis gloeocapsoideis, perithecio gonidiis destituto et sporis muralibus distinguitur.

On rocks along an open roadside near Mayaguez, Fink *1286* (type).

6. **Bacidia millegrana epichlorella** Vainio (n. subsp.).

Epithecio aeruginoso-fuligineo aut partim olivaceo a *Bacidia subluteola* (Nyl.) differens. Thallus albidus, hypothallo nigro.

Apothecia disco nigricante, nudo. Perithecium decoloratum. Hypothecium fuscum aut fulvofuscescens, fulvescensve. Sporae aciculares, long. 50–83, crass. 2.5–4 μ, septis usque ad 11. Corticola.

On bark in woods near Aibonito, Fink *1755*.

7. **Bacidia tristis** Vainio (n. sp.).

A *B. Lafayetteana* Vainio (Lich. Bras. Exs. n. 295) sporis brevioribus differens. Thallus verruculoso-inaequalis, cinereo-glaucescens. Apothecia sat crebra, lat. 0.5–0.3 mm, late adnata, KHO non reagentia, disco plano, demum convexo, fuscescente aut p.p. rufescente, nudo, opaco, margine concolore, sat tenui, haud prominente, persistente aut demum excluso. Hypothecium superne rufescens, inferne pallidum. Perithecium extus pallidum, intus rufescens aut in margine fere totum rufescens. Hymenium circ. 60 μ crassum, decoloratum aut epithecio pallido, iodo caerulescens. Sporae aciculares rectae, pauciseptatae, long. 25–28, crass. 2–2.5 μ. Gonidia simplicia, diam. 5–13 μ, membrana sat tenui. Corticola.

On bark in woods near Naranjito, Fink *351* (type).

8. **Bilimbia Finkii** Vainio (n. sp.).

Thallus sat tenuis, laevigatus aut leviter verruculoso-inaequalis. Apothecia crebra et partim confluentia contiguave, lat. 0.5–0.3 mm, tenuia, late adnata, testacea, haud pruinosa, margine tenuissimo, concolore, subpersistente. Perithecium pallidum aut intus decoloratum, plectenparenchymaticum, cavitatibus cellularum 4–10 μ latis. Hypothecium pallidum, hyphis suberectis. Hymenium 40–50 μ crassum, iodo caerulescens. Epithecium pallidum. Paraphyses arcte cohaerentes, parum gelatinosae. Sporae 8:nae, distichae, decolores, fusiformes aut ovoideo-fusiformes, apicibus acutis obtusisve, rectae, 3-septatae, long. 11–13, crass. 3 μ. Gonidia subellipsoidea globosave, diam. 6–10 μ, simplicia, membrana sat tenui. Lignicola.

On posts in an open field near Rio Piedras, Fink *534* (type); near Aibonito, Fink *1928*.

9. **Lecidea** (*Biatora*) **manatiensis** Vainio (n. sp.).

Thallus indistinctus, calci substrati immixtus, macula albida aut subglaucescente indicatus. Apothecia dispersa, lat. 1–0.7 mm, elevata, praesertim primum subturbinata, basi angusta, disco plano, demum saepe convexo, fusco aut cinereo-rufescente, opaco, nudo, margine modice incrassato, haud aut parum

prominente, concolore aut pallidiore, saepe demum excluso. Perithecium plectenparenchymaticum, cavitatibus 8–10 μ latis, extus pallescens, intus rufescens. Hypothecium rufescens, KHO non reagens, parte inferiore decoloratum et leviter myelohyphicum (hyphis haud conglutinatis), sed gonidiis destitutum. Hymenium 90–110 μ crassum, iodo caerulescens. Epithecium rufescens, KHO non reagens. Paraphyses arcte cohaerentes. Sporae 8:nae, distichae, decoloratae, oblongae, simplices, long. 10–15, crass. 5–7 μ. Gonidia globosa, diam. 7–9 μ, membrana sat tenui. Calcicola.

On rocks in an open field near Manati, Fink *2037*.

10. **Lecidea hilariella** Vainio (n. sp.).

A *L. granulosa* (Ehrh.) Ach. var. *hilari* (Nyl.) apotheciis pallido-cinerascentibus minoribusque et soraliis rotundatis leviter differt, et forsan non autonoma species. Thallus verruculosus, cinerascens et impure albidus, soraliis circ. 0.5(–1) mm latis, crebris instructus, KHO cum $CaCl_2O_2$ intus rubescens. Apothecia lat. 0.5–0.8 mm, basi leviter constricta, disco pallido-cinerascente aut p.p. subtestaceo, nudo, plano aut demum convexo, margine vulgo pallido, modice incrassato, primum prominente, subpersistente. Hypothecium albidum aut p.p. pallido-subrubricosum, ex hyphis suberectis formatum. Hymenium circ. 35 μ crassum. Epithecium pallido-fulvescens, granulosum, KHO non reagens. Paraphyses arcte cohaerentes. Sporae 8:nae, distichae, decolores, simplices, ellipsoideae, long. circ. 8, crass. 3.5 μ. Gonidia pleurococcoidea. Corticola.

On bark in an open field near Mayaguez, Fink *1237*.

11. **Gyrocollema scyphuliferum** Vainio (n. gen. et n. sp.).

Thallus calci substrati immixtus, macula albido-glaucescente indicatus. Apothecia sat crebra, adnata, basi parum constricta, lat. 0.5–0.3 mm, bene urceolata, disco profunde impresso, margine bene elevato, modice incrassato, integro, nigro. Perithecium rubricoso-fuligineum, hyphis sat leptodermaticis, conglutinatis. Hypothecium parte inferiore fuscescens aut pallido-fuscescens, superne anguste pallidum. Hymenium circ. 75 μ crassum, iodo persistentes caerulescens. Epithecium fuscescens, KHO non reagens. Paraphyses arcte cohaerentes, ramoso-connexae. Sporae 8:nae, distichae, decolores, ellipsoideae oblongaeve, apicibus obtusis, simplices, long. 8–12, crass. 3–7 μ. Gonidia nostocacea, cellulis aeruginosis, concatenatis et saepe etiam simplicibus, globosis aut ellipsoideis, long. 3–7, crass. 3–6 μ, membrana inconspicua, strato gelatinoso haud evoluto, hetero-

cystis nullis. Calcicola.—Apothecia facie externa fere sicut in *Gyrostomo scyphulifero*.—Genus *Gyrocollema* Vainio gonidiis nostocaceis, perithecio lecideino, paraphysibus ramoso-connexis, sporis simplicibus et thallo crustaceo, calci immixto, distinguitur et ad Collemaceas pertinet.

On rocks on an exposed hilltop near Yauco, Fink *1563*.

12. **Lecanactis melanocheiloides** Vainio (n. sp.).

Thallus tenuis, sat laevigatus aut levissime verruculoso-inaequalis, glaucescens. Apothecia dispersa, lat. 1–1.5 mm, late adnata, basi leviter constricta. Hypothecium et perithecium fuscofuliginea. Hymenium 110–130 μ crassum, iodo pulchre vinose rubens (haud caerulescens). Epithecium pallidofuscescens vel subrubricosum. Paraphyses parce ramoso-connexae, apices versus sensim incrassatae et abundanter subdichotome ramosae, ramis intricatis. Sporae 8:nae, polystichae, fusiformi- vel aciculari-subbacillares, decoloratae, septis 13–19, membrana leviter incrassata, in KHO turgescente, long. 46–66, crass. 5–7 μ. Gonidia chroolepoidea, crass. 8 μ. Corticola.

On bark in woods near Mameyes, Fink *768*.

13. **Arthoniactis gibbosa** Vainio (n. sp.).

Thallus calci substrati immixtus, macula albido- aut subfumoso-cinerascente indicatus. Apothecia dispersa, adnata, basi haud aut parum constricta, lat. 0.5–0.7 mm, nigra, nuda, KHO non reagentia, disco plano, vulgo papillato, margine prominente, modice incrassato, crenulato verruculosove. Perithecium fuscofuligineum. Hypothecium fuscescens. Hymenium 75–70 μ crassum, iodo non reagens. Paraphyses increbre ramoso-connexae, crass. 1–1.5 μ, apicem versus saepe sensim incrassatae (–3 μ), apice simplices aut subsimplices, arcte cohaerentes. Sporae 8:nae, ovoideo-oblongae, 1-septatae, long. 20–24, crass. 7–10 μ, decolores (demum saepe morbose nigricantes). Calcicola. —Genus *Arthoniactis* (Vainio, Cat. Welw. Afr. Lich. p. 430) sporis 1-septatis a *Lecanactide* differt.

On rocks on an exposed hillside near Yauco, Fink *1636*.

14. **Thelotrema** (*Brassia*) **pauperculum** Vainio (n. sp.).

Thallus sat crassus, verrucoso-rugosus, stramineo-glaucescens, KHO demum rubescens. Apothecia thallo immersa, partim crebre aggregata, disco punctiformi, circ. 0.05 mm lato, fuscescente, leviter aut haud impresso. Parathecium tenue, fuscescens. Columella haud evoluta. Epithecium fuscescens. Sporae 8:nae,

distichae, decoloratae, ellipsoideae, septis transversis 3–5, demum loculis 1–3 bicellulosis (submurales), membrana sat crassa (crassit. 15 μ), iodo caeruleo-violascentes, long. 16–22, crassit. 9–13 μ. Facie externa subsimile *T. terebrato*, sed sporis submuralibus ab eo differens. Corticola.

On bark in woods near Rio Piedras, Fink *519*.

15. **Thelotrema** (*Leptotrema*) **compunctum** (Sm.) Nyl. f. **portoricensis** Vainio (n. f.).

Parathecio albido instructa. Sporae long. 25–36, crass. 9–16 μ. Corticola.

On bark on an exposed hilltop near Aibonito, Fink *1749*.

16. **Thelotrema** (*Ocellularia*) **alboolivaceum** Vainio (n. sp.).

Thallus tenuis, continuus, verruculis minutissimis, leviter prominentibus inspersus, olivaceus, KHO demum rubescens, leviter nitidus. Apothecia lat. 0.8–0.5 mm, prominentia, latere praerupto, disco albido-pruinoso, margine prominente, albo, saepe duplice, margine interiore fissura a margine exteriore disjuncto, tenuissimo, ostiolo circ. 0.5 mm lato. Perithecium pallidum decoloratumve. Columella haud evoluta. Sporae 8:nae, distichae, decoloratae, iodo violascentes, subfusiformes, apicibus obtusis aut raro acutis, 3-septatae, long. 16–19, crass. 5–6 μ, haud gelatinosae. Corticola.—Facie externa subsimile est *T. porinoidi* Mont. (*T. bicavato* Nyl.), sporis minoribus ab ea differens.

On bark in woods near Vega Baja, Fink *2153*.

17. **Thelotrema** (*Ocellularia*) **subcrassulum** Vainio (n. sp.).

Vix nisi sporis iodo violascentibus a *T. Crassulo* Nyl. differt, quae nota in hoc genere est constans (quoad sporas maturas). Thallus stramineo-glaucescens, nec iodo nec KHO reagens (post tempus longius subrufescens), vix distincte verruculis minutissimis inspersus, nitidus, sat crassus. Apothecia crebra, thallo immersa, margine ostiolari haud prominente, saepe leviter impresso, ostiolo minutissimo, circ. 0.05 mm. lato. Perithecium albidum. Columella haud evoluta. Epithecium albidum. Sporae 8:nae, distichae, decoloratae, iodo violescentes, oblongae, apicibus obtusis rotundatisve, 3-septatae, loculis apicalibus interdum majoribus, long. 11–14, crass. 4.5–5 μ. Corticola.

On bark in woods near El Yunque at 3000 ft., Fink *725* (type).

18. **Bottaria** (*Anthracothecium*) **libricola** (Fée) Vainio, Jour. Bot. **34:** 265. 1896. f. **nana** Vainio (n. f.).

Apothecia substrato thalloque immersa, tantum ostiolo minutissimo indicata. Corticola.

On bark on an exposed hilltop near Yauco, Fink *1669* (type). Near Vega Baja, F. L. Stevens *2491*. Algal host *Trentepohlia*.

19. **Pyrenula atrofuscescens** Vainio (n. sp.).

Thallus sat crassus, modice incrassatus, epiphloeodes, laevigatus, fuscescens, sat opacus, rimosus, hypothallo indistincto. Apothecia crebra, verrucas conoideo-hemisphaericas, circ. 0.5 mm latas formantia. Perithecium fuligineum, conoideo-hemisphaericum, fuligineum, basi tenue, latere circumcirca angulosum (haud alatum), parte inferiore strato thallino obductum, vertice late denudato. Sporae 8:nae, fusiformi-oblongae, apicibus obtusis, lateribus convexis, fuscescentes, haud gelatinosae, papillis apicalibus nullis, 3-septatae, loculis apicalibus minoribus, long. 18–21 (–16), crass. 8–10 μ. Corticola.—Proxima *P. atropurpureae* (Eschw.) Müll. Arg. (Flora **67:** 665. 1884) etiam sec. specim. orig. in herb. Nyl.

On bark in an open field near Rio Piedras, Fink *504*. Algal host *Trentepohlia*.

20. **Porina subprospersella** Vainio (n. sp.).

Thallus calci immixtus. Apothecia crebra numerosissimaque, lat. 1–1.5 mm, omnino aut parte inferiore substrato immersa, nigra. Perithecium dimidiatim fuligineum. Nucleus decoloratus, iodo non reagens. Paraphyses simplices, crass. 1 μ. Asci cylindrici, membrana sat tenui etiam in apice, long. 70–100, crass. 10–12 μ. Sporae 8:nae, distichae aut subdistichae, fusiformi-oblongae aut subovoideo-fusiformes, decoloratae, 1-septatae, long. 16–21, crass. 3–5 μ. Gonidia trentepohliacea, crass. 10–13 μ, membrana sat tenui. Calcicola.—Habitu subsimilis est *Arthopyreniae prospersellae* (Nyl.).

On limestone on an exposed hilltop near Yauco, Fink *1398* (type). Near Frujilla Alta, Britton *8663, 8665*.

21. **Arthopyrenia leptosporiza** Vainio (n. sp.).

Thallus sat tenuis, verruculoso-areolatus aut sat continuus, terra ochracea pallide ochraceo-tinctus, opacus. Apothecia crebra, thallo immersa, vertice nigro vix 0.1 mm lato denudato, haud aut levissime prominente. Perithecium fuscum, basi

albidum. Nucleus albidus, iodo non reagens. Paraphyses parcae, parce ramoso-connexae. Asci subcylindrici aut subventricoso-cylindrici, long. 45–50, crass. 10–13 μ, in apice membrana modice incrassata. Sporae 8:nae, distichae, decoloratae, ovoideo-oblongae, haud aut levissime constrictae, 1-septatae, long. 14–17, crass. 3–4 μ. Gonidia trentepohliacea, cellulis p.p. concatenatis, 6–9 μ crassis. Thallo ab. *A. fluctigena* Nyl. differt. Terricola.

On moist soil near Yauco, Fink *1753*.

22. **Mycoporum integrum** Vainio (n. sp.).

Thallus sat tenuis, verruculis et granulis soredioideis inspersus, opacus, albido-glaucescens. Apothecia sat crebra, rotundata aut irregularia, lat. circ. 0.2–0.3 (–0.4) mm, parum prominentia, fusconigra, nuda. Perithecium integre, fusco-fuligineum. Nucleus iodo non reagens. Asci ventricosi, long. 90–92, crass. 42–45 μ. Sporae 8:nae, decoloratae, murali-divisae, septis transversis 7, medio constrictae, haud gelatinosae, long. 30–33, crass. 13–14 μ. Gonidia globosa, diam. 6–7 μ, tantum simplicia visa, membrana sat tenui. Corticola.—Facie externe subsimile *M. pyrenocarpo* Nyl.

On bark near Aibonito, Fink *1800*. Algal host *Palmella*.

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IS PSALLIOTA BRUNNESCENS UNDER CULTIVATION?

F. C. Stewart

(With Plates 6 and 7)

Some brick spawn used in mushroom beds under the benches of a greenhouse at the New York Agricultural Experiment Station was obtained from an "old and reliable" firm of seedsmen in New York City. It was purchased as "American spore culture mushroom, cream white variety."

All of the mushrooms produced from this spawn were altogether different from the common mushroom, *Psalliota campestris*. They were reddish-brown, fibrillose-scaly, and usually of large size. Being unable to determine the species, we sent specimens to Dr. C. H. Kauffman, Ann Arbor, Michigan, for identification. After a careful study of the plants Dr. Kauffman expressed the opinion that they belonged to *Psalliota brunnescens*, a species described by Peck (**4**) in 1900.

This identification is necessarily uncertain, because, as stated by Duggar (**1**), the cultivated form of a mushroom may be quite different from its wild form. In a letter dated April 26, 1926, Dr. Kauffman says: "Of course it may not be *P. brunnescens*, but I know of no other species to which it can approach so closely. It certainly should not be considered a variety of *P. campestris*, *P. arvensis*, or *P. subrufescens*, unless cultivation of agarics causes more far-reaching changes than any known in plants and due to cultivation of this kind."

It should be noted here that Murrill (**3**) once wrote as follows concerning *Psalliota brunnescens:* "My *A*[*garicus*] *campester hortensis* described and figured in Mycologia for July, 1914, seems very near this species." Previously, Murrill (**2**) had stated that his variety is "often cultivated but is rarely found wild."

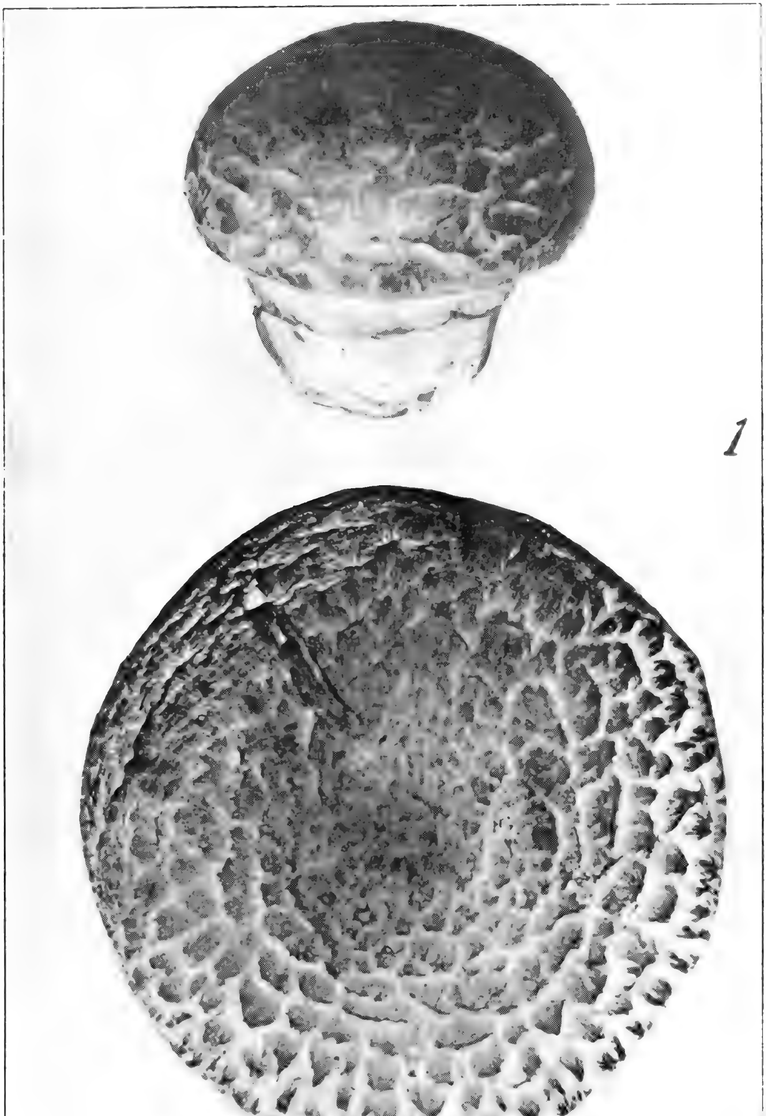
Our fungus is characterized as follows: *Pileus* 5–12 cm. broad, convex to convex-expanded, firm, dry, reddish-brown, fibrillose-scaly, margin at first incurved and surpassing the lamellae;

flesh thick, compact, white, unchanging or becoming slightly rufescent when broken; *lamellae* crowded, free but reaching the stipe, rounded behind or truncate from pressure against the stipe, often appearing adnate, narrow, lanceolate, often forked, at first whitish or pallid, then pink and finally brown, on the edge whitish and minutely uneven due to numerous tufts of clavate, hyalin, sterile cells; *stipe* 3–6 cm. long, 2.5–4.5 cm. thick, tapering downward, or largest at the annulus, silky, white within and without, becoming rufescent when bruised or cut below the annulus, solid or persistently stuffed, rarely with a small hollow; *veil* thick, forming a tumid annulus, double, outer layer sheathing the base or lower half of the stem, the two layers quite concrete with each other, tinged like the flesh or becoming "fawn" (R) color in age; *annulus* median, persistent, up to 5–6 mm. thick in the early tumid condition, flaring upwards at first, frequently striate on the upper surface, veil-remnants often left on the appendiculate margin of the pileus, forming a thick striate rim; *spores* broadly elliptical, 4–6 $\times$ 6–8 μ, purple-brown; basidia 2-spored; *taste* of fresh mature plant slightly disagreeable. Edible.

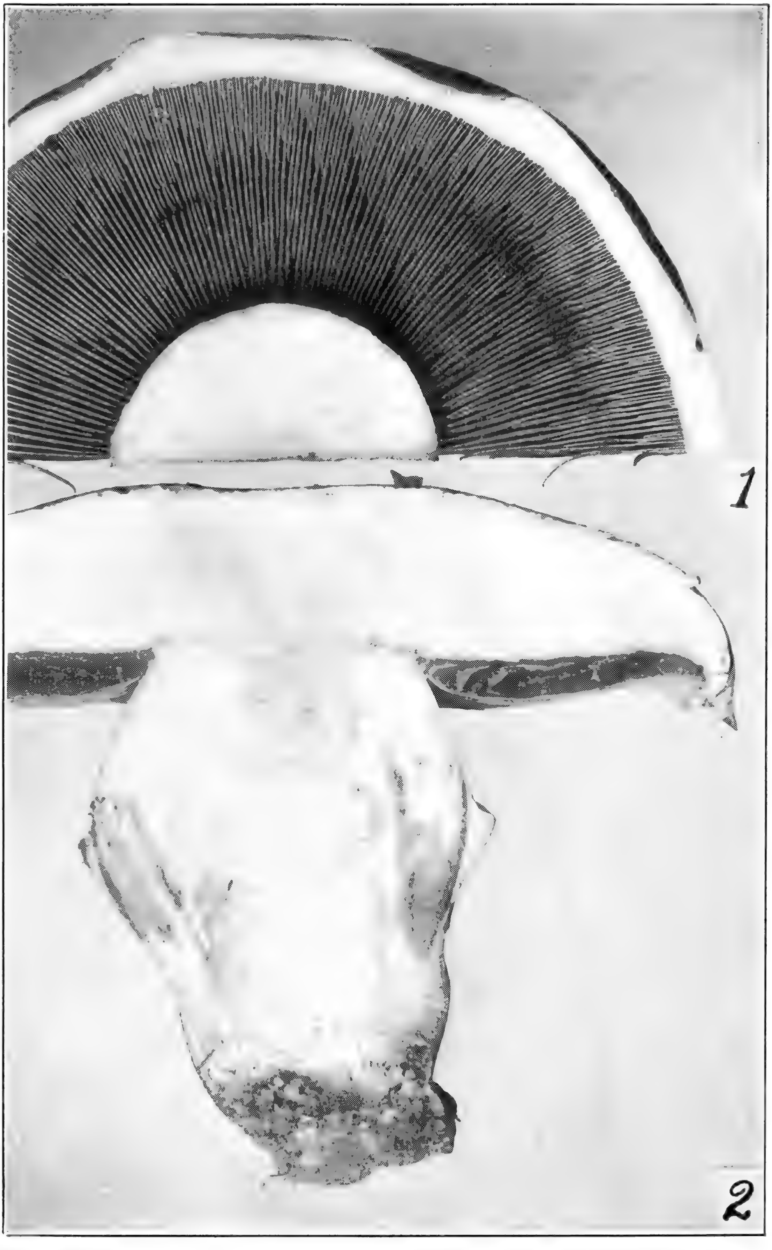
The average weight of the plants was 86.7 gms. Several of the larger ones weighed over 200 gms. each. In cross-sections of the stipe made below the annulus a small circular area at the center remains white while the remainder promptly becomes rufescent. Plants placed in formaldehyde solution promptly give the solution a reddish-brown color. Peck states that plants of *Psalliota brunnescens* frequently develop fully beneath the surface of the ground. None of our plants have done this.

The lamellae often contained brown hyphae belonging to some other fungus. These were readily demonstrated by a microscopic examination of pieces of lamella which had been placed in water under a coverglass on a glass slide and crushed thin by gentle pressure on the coverglass. They were usually 8–10 μ in diameter, simple or sparingly branched, sinuous, and with but few cross-walls. When simple their course of direction was usually at right angles with the edge of the lamella.

Often they could be traced clear across the field of the microscope. No sign of fructification was observed in connection with them. It was found easy to detect them in the lamellae of dried



PSALLIOTA BRUNNESCENS (?)



PSALLIOTA BRUNNESCENS (?)

specimens as well as in fresh material. This phenomenon is quite new to the writer, but Dr. Kauffman informs us that he has observed similar brown hyphae in the lamellae of other agarics.

Psalliota brunnescens is rare in the wild state and we have found nothing in the literature, except Murrill's suggestion above mentioned, to indicate that it is under cultivation by mushroom growers. Accordingly, it would be of interest to know how our plant got into cultivation, but all that we have been able to learn about it is that the spawn which we used was prepared by the American Spawn Company, St. Paul, Minnesota.

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GENEVA, N. Y.

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2. **Murrill, W. A.** Dark-spored agarics—III. Mycologia **14**: 212. 1922.
3. ——. Illustrations of fungi—XVIII. Mycologia **6**: 166. 1914.
4. **Peck, C. H.** New species of fungi. Bull. Torrey Club **27**: 16. 1900.

EXPLANATION OF PLATES

Psalliota brunnescens Peck (?) grown from commercial brick spawn in mushroom beds in a greenhouse. All figures natural size. From photographs by W. O. Gloyer.

PLATE 6

Fig. 1. A "button."
Fig. 2. Surface view of the pileus of a mature plant.

PLATE 7

Fig. 1. The hymenium and a cross-section of the stipe.
Fig. 2. Longitudinal section of a mature plant.

A COMPARISON OF TWO SPECIES OF PLECTODISCELLA

A. E. Jenkins and J. G. Horsfall

(With 2 Text figures)

Osterwalder (7) at the Wädenswil Experiment Station in Switzerland has recently reported upon a fungus which he isolated from small flecks on fruits of the Jonathan apple[1] and which he considered to be Jonathan spot; this fruit spot was brought to his attention by Dr. Zschokke, at the same Institution, who had earlier referred to it in a horticultural description of this apple variety. Osterwalder's observations of the fungus did not permit of its classification. A culture of this fungus, contributed through the kindness of Dr. Osterwalder, shows, in general, the distinctive morphological characters of the genus *Plectodiscella* as exemplified by *P. veneta*. Chiefly on this basis and that of certain other related information the Osterwalder fungus, for which fruiting forms had not previously been observed, is now assigned to an ascomycetous species, namely *Plectodiscella Piri* of the family Plectodiscelleae. This classification was established in 1914 by the Russian investigator, Woronichin (8), in order to designate an ascomycetous fungus which he had discovered previously in Transcaucasia. As he observed it the fungus caused a small leaf spot on foliage of unnamed varieties of both cultivated apple (*Malus*) and pear (*Pyrus*).

Plectodiscella veneta is the only fungus other than the type to have been classified in this family and genus. Both species have since been included by Arnaud (1) in the *Elsinoe* Section of the genus *Uleomyces* but the basis for this classification will not be considered at this time. In this section Arnaud (1) also lists *E. viticola* Rac., which is suggestive of a possible perfect stage of *Sphaceloma ampelinum* de Bary (3) referred to below.

[1] Neither of the authors is very familiar with the Osterwalder fruit spot or the Jonathan spot, and therefore neither is in a position to express an opinion as to their identity.

IDENTITY OF THE OSTERWALDER FUNGUS WITH PLECTODISCELLA PIRI

Woronichin (**8**) published a detailed description of *Plectodiscella Piri* with illustrations showing the development of its ascomycetous stage on leaves of apple or pear. Osterwalder's (**7**) article contains a careful description of all the characters of the apple fruit spot fungus as he observed them. However, unless Osterwalder were especially interested in the genus *Plectodiscella*, it would not be expected that he would have noted the identity of the Swiss fungus, fruiting forms of which were unknown, with an ascomycetous fungus which had been reported as occurring not on the fruits but on the leaves of the apple as well as on those of the pear.

A contribution of specimens from the type material of *Plectodiscella Piri* was made to the senior author in June, 1926, through the kindness of Dr. N. N. Woronichin and Dr. A. A. Jaczewski. A morphological comparison of the fungus on these specimens with the Osterwalder culture, together with the information contained in the two articles just cited, and as herein reviewed, confirms the opinion that the Osterwalder fungus is identical with *P. Piri*. An illustration of the leaves of apple and pear constituting a part of the specimens received from Russia is shown in Figure 1. It is thought important to state that in addition to mycelial growth and asci described by Woronichin a mass of unattached conidia was seen in a preparation from one of these specimens. These were similar to the conidia which, as mentioned later, were obtained in the culture of the Osterwalder fungus. Macroscopically, the culture received from Osterwalder agreed in every respect with his detailed description and illustrations of the organism obtained by him from the fruit spot on apples from Switzerland.

The conidial stages of *Plectodiscella Piri* Wor. (**8**) and of *P. veneta* Burk. (**4**), as observed in culture by the authors, and the conidial stage of *P. veneta*, as pictured or described in the earlier literature, are as correspondingly similar as are the original descriptions and illustrations of their perfect stages. By comparing the gross cultural characters of the Osterwalder fungus with those of cultures of *P. veneta*, of which one strain was

contributed by L. K. Jones (**5**) and the others isolated by one of the authors, the two are easily distinguished although they are so nearly alike that either one could be employed interchangeably

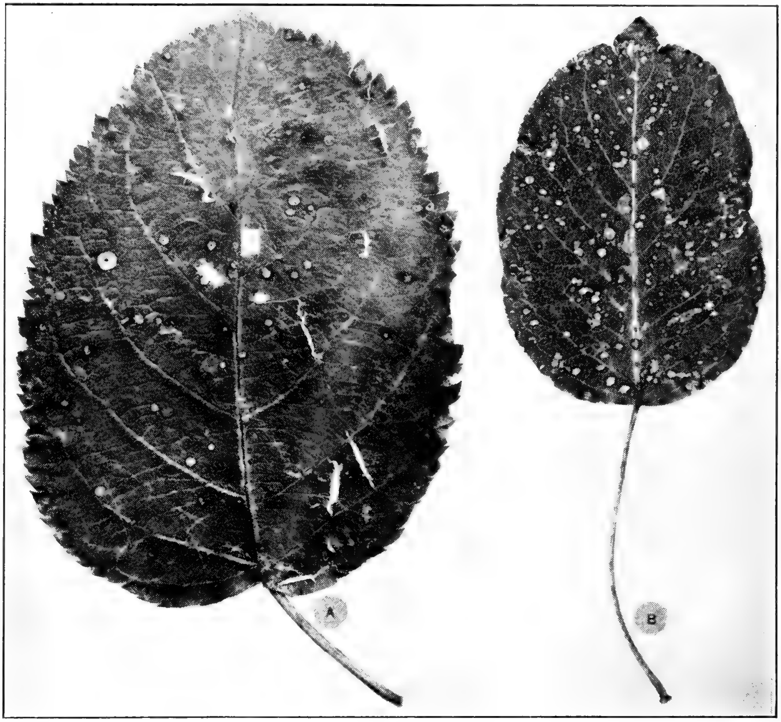

FIG. 1. *Plectodiscella Piri* Wor. on leaves of apple (A) and on pear (B) gathered by Woronichin in Transcaucasia, Russia, August, 1919. Photograph by W. R. Fisher.

as representative of the genus *Plectodiscella*. On the basis of the available information there would then seem to be no question but that the Osterwalder fungus belongs to this genus, and evidently represents the type species. There remains the possibility, of course, that it may be varietally different from *P. Piri* as it occurs in Russia. Even if cultures from Russia were available, considerable detailed investigation would doubtless be required before much additional definite information bearing on this point could be obtained.

In culture the Osterwalder fungus is not only similar to

Plectodiscella veneta, which, as recently demonstrated (**5**) in its vegetative characters is referable to the form genus *Sphaceloma* de Bary (**3**), but is also equally like to the other forms of *Sphaceloma* which have been studied by the writers (**2**, **5**, **6**), among which may be named *S. ampelinum* de Bary, *S. fawcettii* Jenkins, *S. symphoricarpi* Barrus & Horsfall, and a species as yet undescribed, occurring on the avocado (*Persea*), as well as a *Sphaceloma* occurring on the rose (*Rosa* [2]) which has not yet been definitely determined.

DESCRIPTIVE ACCOUNT

Osterwalder's (**7**) description of the fruit spot with which this fungus is associated is as follows:[3] "The fruit spot is confined chiefly to the blush side of the Jonathan apple, which is often entirely dotted with 50 or more small, punctiform, round, smooth, shining spots about 2 mm. in diameter. A lenticel forms the center of the spot, the lesions being scarcely more than colored regions of the skin penetrating a small number of cell layers, usually about seven, and presenting a brown appearance." Woronichin (**8**) describes the spot as occurring "on the upper side of the leaf and consisting of a light gray center with a brownish border. They are round, 1–2 mm. in diameter or oval up to 2–4 mm. Adjacent spots seldom unite."

Osterwalder's (**7**) description of the morphology and development of the vegetative growth of the fungus in these small discolored areas is here translated in full: "The hyphae grow between and often within the dead cells, being most numerous just below the epidermal layer. In color they are hyaline, differing in this respect from the apple scab organism (*Venturia inaequalis* (Cooke) Aderh.) and from most other parasitic fungi in that they are not cylindrical or tubular but appear as series of chains or cells of unequal diameter, in this respect bearing a resemblance to the small uneven sized bones of the fingers of a human skeleton. Between the cells of the apple, the fungus resembles somewhat the mycelium of Exoascus species in plum

[2] The writers are grateful to Prof. L. M. Massey for a culture of this fungus contributed by him in 1925, he having gathered and grown it in pure culture as early as 1923.

[3] In this Section the quotations represent more or less free translations from Dr. Osterwalder's (**7**) or Dr. Woronichin's (**8**) papers.

pockets or 'hexenbesen' of cherry trees. Its cells often contain a larger or smaller number of fat globules. Through the aperture of the lenticels the stroma may emerge, growing upward, rope-like, out of the interior of the spots, terminating in a layer of round yeast-like cells." Conidia or other propagative organs are sought for in vain.

This description compares fairly well with Woronichin's account of the ascomata in their earlier development in the leaf of apple or pear, discussed in connection with his characterization of the family Plectodiscelleae.

Osterwalder isolated the fungus from the fruit spots and noted its comparatively slow growth on both agar and gelatine media. On gelatine media he states that in the course of two or three weeks it reached a diameter of about 6 mm., being red in color at the beginning and, later, brownish black and wrinkled. He observed that about the edge of the stromatic growth on gelatine, which it liquifies to some extent, yeast-like cells or chains of unequal diameter were formed, which, with slight pressure, separate from one another and become scattered about again reproducing new colonies. For the most part these "yeast-like cells or chains" were probably recently germinated conidia or possibly in part primary or secondary conidia. Osterwalder reports the cardinal temperatures for growth of the fungus as follows: Minimal, 5°; optimal, 21°; and maximal, 29° C.

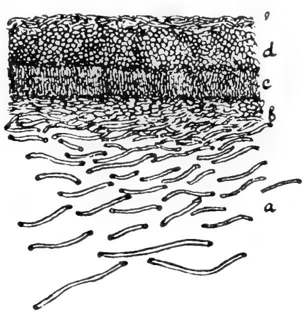

FIG. 2. *Plectodiscella Piri* Wor. Microscopic cross-section of ten-weeks-old agar culture grown at 21° C. After Osterwalder.

Osterwalder's (**7**) description of the fungus as it developed in the fruit spot and in culture could well be considered as in

complement to Woronichin's (**8**) description of *Plectodiscella Piri* in another phase of its development. It is of interest to note that his description and discussion of the tissue-like layers composing a microscopic section of an old agar culture of his fungus (FIG. 2), quoted below, corresponds closely with Woronichin's (**8**) somewhat similar account and discussion of the structure of the older ascomata of this fungus growing on a substratum composed of leaf tissue of the apple or pear.

A description of the cultural growth of members of the genus *Plectodiscella* or *Sphaceloma* is of prime importance for purposes of identification. For this reason Osterwalder's (**7**) description of what may now be termed the cultural growth of *Plectodiscella Piri*, typifying alike the general cultural characters of the relatively new genus *Plectodiscella* and the family Plectodiscelleae, is here quoted in full in the original.

"Auf Agar wuchs der Pilz besser als in Gelatine, und wurde auch hier zu einer vielfach gefalteten Haut, die an Nostoc-Gallerten erinnerte, umso mehr, als die Falten graugrüngelb bis kastanienbraun erschienen (Abb. 4). Nur die Randpartien weisen zunächst eine weissflaumige Beschaffenheit auf, verfärben sich aber später braunrot. Der Pilz wächst tief in das sich hiebei grünlich gelb verfärbende Agar hinein, erscheint hier auch fädig, hyalin, meist $1\frac{1}{2}$–2 μ dick. Die gefaltete Haut an der Oberfläche des Agars erinnert im Querschnitt (Abb. 5 = Fig. 2) an ein Sclerotium, unreifes Apothezium oder sonstigen Fruchtkörper eines höheren Pilzes. Nach innen in die Tiefe frei und locker wachsend (Abb. 5a), verschlingen sich die Fäden nach oben hin immer enger ineinander, bilden ein dichtes Geflecht, eine Art Subhymenialschicht oder Hypothecium (Abb. 5b). An dieses Pilzgeflecht schliesst sich dann eine feinfaserige Gewebeschicht (Abb. 5c), die wieder überlagert wird von einem pseudoparenchymatischen Gewebe (Abb. 5d), das nach und nach in Einzelfäden sich auflöst, wodurch die Oberfläche ein flaumiges Aussehen erhält. (Abb. 5e). Die Reinkulturen des Pilzes in Gelatine, namentlich aber auf Agar, erinnern im Aussehen und ihrer inneren Struktur an einen höheren Pilz. z.B. an eine Tremella. Auch in Nährflussigkeiten, z.B. einem unvergorenen Birnsaft, wuchs der Pilz nicht ausgiebig, bildete innerhalb drei Wochen bis 1 mm gross runde Flöckchen mit dünnem hyalinem Myzel, die nach weiteren vier Wochen einen Durchmesser von 2–3 mm erreichten. Ältere Fäden verfärbten sich bräunlich, beim Drucken auf das Deckglas in kürzere 1–2 zellige Fragmente zerfallend. Auch bei diesen Kulturen trat eine Sporenbildung irgend welcher Art nicht ein."

To this description may be added the fact that conidia of this fungus as observed by the authors are mostly oblong-elliptical, hyaline, often bi-guttulate. As produced in the Osterwalder culture they measured 4–9 $\times$ 1.6–2.5 μ.

For convenience in reference and to bring together in one place all available information descriptive of *P. Piri* a copy of Woronichin's (**8**) description of the ascomata of this species and of the family Plectodiscelleae is likewise quoted:

"*Plectodiscelleae* WORONICHIN (nova familia). Ascomata im Substrat lagernd, später von der deckenden Cuticula sich befreiend, eng mit der Basis an das Substrat anwachsend, meist von polsterartiger Form, welche nach den Rändern zu sich verdünnt und nicht scharf begrenzt ist, mit gut entwickeltem Epithecium-Schildchen, welches aus einreihigen polygonalen dunkelgefärbten Zellen besteht und sich am Rande mit dem schwach ausgebildeten paraplectenchymatischen Hypothecium vereint. Schildchen anfangs ununterbrochen, später stellenweise resorbiert. Ascen in dem Ascomaraume regellos eingebettet, einander eng berühend oder durch eine Masse von undeutlicher fädiger Structur getrennt, oval, 8 sporig.

"*Plectodiscella Piri* WORONICHIN (nov. gen. et spec.) Flecke grünlichweiss, mit braunem Rand, rundlich, 1–2 mm. im Durchmesser, oder oval 4 × 2 mm. sich selten vereinigend, oberseits der Blattspreite. Die Ascomata bilden sich in den Epidermiszellen der lebenden Blätter, später die Cuticula durchbrechend, rundlich oder länglich auf dem Querschnitt des Blattes 75–500 μ breit und 35–145 μ hoch, oft sich vereinigend. Ascen oval, an der Spitze verdickt, meist mit einem sehr kurzen Stiel verschen, 21–23 × 15–19 μ, im Ascoma regellos eingebettet; Sporen 8, meist parallel im Ascus oder unregelmässig liegend, breit spindelförmig, farblos, nach einem Ende mehr verschmälert als zum anderen, am oberen Ende ein wenig abgestumpft, 4 zellig, 12–14 × 4.5 μ. Schildchen (Epithecium) aus vieleckigen oder rundlichen braunen Zellen von 7,5 μ im Durchmesser bestehend, Hypothecium hell gefärbt, dünn, paraplectenchymatisch.

"Auf den lebenden Blättern von Pirus malus L. (cult.), Kaukasus, Gouv. Cernomorsk bei Volkovskaja, 7. Sept. 1912; auf lebenden Blättern von *Pirus malus* L. (cult.) und *P. communis* L. (cult.), Kaukasus, Gouv. Cernomorsk bei Macesta, 28. Aug. 1913, leg. N. WORONICHIN."

It thus appears that the fungus which Osterwalder found occurring in a fruit spot on Jonathan apple in Switzerland is to be referred to as *Plectodiscella Piri* Woronich. Further studies are essential to a more complete knowledge of its range as well as of its economic significance.

The specimens of *Plectodiscella Piri* from Russia and the original culture contributed by Osterwalder have been deposited in the Mycological Herbarium of the U. S. Bureau of Plant Industry.

BUREAU OF PLANT INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.
DEPARTMENT OF PLANT PATHOLOGY,
CORNELL UNIVERSITY,
ITHACA, N. Y.

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NOTES AND BRIEF ARTICLES

Dr. H. S. Jackson, now at Purdue University, has recently accepted a Professorship in Mycology and Cryptogamic Botany at Toronto University, Toronto, Canada, to take effect in 1929. It is expected that the new position will give Dr. Jackson a chance to devote more time to research work on plant rusts. He is already one of the outstanding Uredinologists of America and is to be congratulated on the new appointment and the opportunities afforded thereby. Dr. Jackson has been devoting considerable time to the study of tropical plant rusts and several noteworthy contributions on this subject have been published in MYCOLOGIA.

Part 7, of Volume 1, Die Röhrlinge (Boletaceae) of Die Pilze Mitteleuropas, by Franz Kallenbach, has just appeared. This part contains full discussions, synonymy, detailed notes and citations to literature of *Boletus flavus* (With.) Fr., and *Boletus viscidus* Fr., with three plates containing numerous colored illustrations of various forms and conditions of these species, and detailed drawings of microscopic characters and habitat photographs. The colored illustrations are remarkable for their detail, variety and apparent accuracy. This work is published by Dr. Werner Klinkhardt, Leipzig, Germany. Price 5 Marks per part. C. L. SHEAR.

COKER'S GASTEROMYCETES

The Gasteromycetes of the Northern United States and Canada by Professor W. C. Coker and Assistant Professor J. N. Couch of the University of North Carolina has just been received. Although a number of American mycologists have worked on this group of fungi, this is the first attempt to bring together under one cover a complete record of our knowledge of these forms. Dr. Coker, the senior author, has been a frequent visitor at The New York Botanical Garden, spending most of his time on the mycological collections. He has also worked in most of the other large herbaria of America and Europe and is eminently

fitted for the task which has just been completed. The work which has been published by the North Carolina Press consists of two hundred and one pages of text and one hundred and twenty-three plates made from life size photographs and drawings of the microscopic characters. FRED J. SEAVER.

CULTURES OF SCLEROTIAL FUNGI

During the past fifteen years the writer has been accumulating cultures of sclerotial fungi of all kinds, in connection with his studies on the taxonomy of *Sclerotinia* and *Botrytis*. The total number of strains which we have had in culture to date approximate sixteen hundred. While some of these have died out we still have growing in stock approximately a thousand strains. Under a special grant from the Heckscher Foundation for Research in Cornell University, we are able to maintain these cultures year after year. Many workers throughout the United States and in other parts of the world have, from time to time, made many contributions of specimens and cultures of sclerotial fungi for our use.

We should greatly appreciate it if all workers who may have occasion to collect or isolate sclerotial fungi of any kind would send us cultures or freshly collected specimens, preferably both, whenever they come to hand. We are glad to make any of our cultures available to other workers in so far as is consistent with our obligations to contributors and the progress of our own investigations, believing that in this way we will be rendering service to our colleagues at very little inconvenience to ourselves.

We are particularly anxious to get cultures of any newly described species whether they be of *Botrytis*, *Sclerotinia* or others of the sclerotial fungi. Workers on any of these forms need have no hesitancy in sending such cultures or forms on which they may be working, as we shall be very glad to maintain them in culture under such restrictions as to distribution or use by us in our investigations as the sender desires to make. Full data as to time, host, place of collection, etc., should accompany the sendings.

The writer invites the hearty coöperation of all workers or collectors of these forms in this effort to maintain a large and representative culture collection of sclerotial fungi. H. H. WHETZEL

THE NORTH AMERICAN CUP-FUNGI

(OPERCULATES)

The above work, an advance notice of which appeared in the July–August number of MYCOLOGIA, was issued December 30, 1928. The volume is somewhat larger than predicted, comprising more than two hundred and ninety pages of text and forty-six plates, two of which are in color, the remainder consisting of half-tones and drawings or combinations of both.

Of the two hundred and eighty valid species recognized in this monograph, more than one hundred are illustrated, eighteen of which are in color. Accompanying each species is a complete list of synonyms which, with the diagnosis, represents the author's version of the species, based on the information at present available. In addition to the valid species, notes on a large number of doubtful forms are appended after the genus in which they would appear to belong. For the first time we have brought together under one cover a complete record of our knowledge of the operculate cup-fungi occurring in North America. While the work is essentially North American, the plants of this group are so cosmopolitan that the majority of the forms will be found in almost any other part of the world where we have the same diversity of conditions.

The author wishes here to announce his intention of continuing the study, not only of the operculate forms but of the inoperculate as well, with the hope of publishing a similar volume on the latter or possibly a combination of the two, provided the demand for the present work seems to warrant it. To this end, material and original photographs are solicited from collectors in other parts of the world.

The book is printed on the same grade of paper and in the same general style employed in MYCOLOGIA, and is bound in "Vellum de Luxe" cloth, and is published entirely at the expense of the author. The price of the volume is five dollars plus twenty-five cents for postage and mailing. More detailed information may be obtained by addressing the author at the New York Botanica Garden. FRED J. SEAVER.

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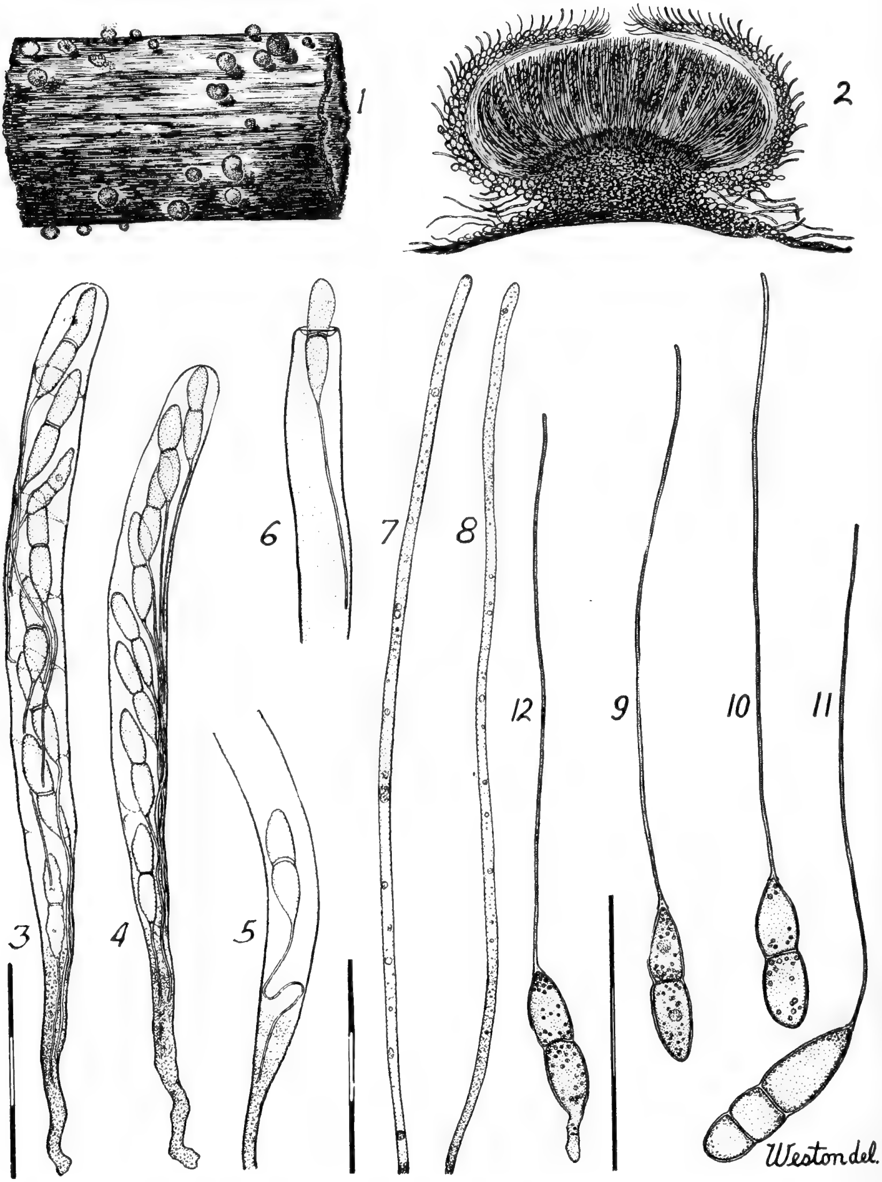

LORAMYCES

MYCOLOGIA

VOL. XXI MARCH–APRIL, 1929 NO. 2

OBSERVATIONS ON LORAMYCES, AN UNDESCRIBED AQUATIC ASCOMYCETE [1]

WILLIAM H. WESTON, JR.[2]

(WITH PLATES 8 AND 9)

INTRODUCTION

In the course of occasional investigations in the various orders of submersed Phycomycetes, a group which to him are among the most interesting of the fungi, the writer has carried on intermittent search for aquatic fungi in other groups and from time to time has encountered representatives of the Fungi Imperfecti and a certain number of Ascomycetes which proved, for the most part, to be either commoner aquatic forms already known, such as *Mitrula* and *Vibrissea;* or forms normally terrestrial perforce persisting for a time in a facultatively aquatic life because the wood or other substratum on which they were growing had become temporarily submerged.

One of the Ascomycetes, however, has been found to be of considerable interest because of its restricted relation to one special substratum within a very limited region, and because of the marked peculiarities of its structure and reproduction in conformity to its obligately aquatic mode of life.

[1] Contribution No. 102 from the Laboratories of Cryptogamic Botany, Harvard University.

[2] The writer wishes to acknowledge his indebtedness to aid from the Milton Research Fund of Harvard University which has facilitated the long-delayed preparation of this paper by relieving him of certain burdens of academic work.

[MYCOLOGIA for November–December (**20**: 305–364) was issued November 1, 1928]

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Although this form was first found twelve years ago its study has been regrettably fragmentary, as the demands of work in other fields have left no opportunity for the intensive investigation of the cytological details of spore formation or the physiological aspects of spore discharge and distribution, which these interesting features demand. Yet as the fungus appears to be one as yet undescribed and as it shows such marked peculiarities of structure, development, and distribution it is hoped that other mycologists may find points of interest in even the incomplete observations embodied in the following paper.

THE OCCURRENCE OF THE FUNGUS

This fungus has been found only on dead, partly softened, though not too old, culms of *Juncus militaris* Bigelow, lying submerged, from a few inches to as much as three feet, in fresh water chiefly in a small pond on Nashawena Island, one of the farther of the Elizabeth Islands situated off the Massachusetts coast, southwest of Woods Hole. It was first found in July 1915 by Ivey Lewis, R. H. Colley, and the writer while conducting a collecting foray of the Alga Course of the Marine Biological Laboratory and since then, in the same spot, it has been collected not only by the writer in 1916, 1922, and 1923 in either July or August, but also on similar yearly collecting trips during almost all of the intervening summers, including 1927, by others, while the writer has been elsewhere.

This pond presents certain distinctive features: it is of fresh water, situated a short distance inland behind rolling sand dunes, and bordered by thickets of shrubs such as bayberry, in depth rather shallow around the edge but deepening rapidly toward the center. In the shallows about the margin especially on the side toward the sea there grows a dense stand of *Juncus militaris* which lessens and hinders any washing movement of waves, partially shades the water, and furnishes an abundant accumulation of submerged culms year after year.

Although in these shallows the water at its very uppermost surface at midday in summer may become well warmed by the sun, further below, especially in the shade of the *Juncus*, its coolness rapidly increases until at a depth of two or three feet

it is usually unpleasantly cold even in July and August. In winter, although no accurate records have been kept for this pond, we may assume from what has been observed in the case of other ponds of similar size and situation that ice forms, even in extremely cold seasons, to a depth of as much as a foot.

The water is fresh and relatively free from sediment although, because of the organic material it contains, its color usually is a rather dark brown.

In spite of the fact that species of *Hapalosiphon*, *Stigonema*, and *Stigeoclonium* frequently are found on the submerged *Juncus* stems near the surface in company with the fungus, the algal flora of the pond is rather scanty, possibly because the water is so dark colored, so shaded by the *Juncus* at the margin and so rapidly deepening toward the center. Nor do the algae, as far as is known, show cases of such restricted distribution as this fungus, although it should be noted, as Dr. Lewis has informed the writer, that *Batrachospermum*, probably because the water is cool and shaded and the distributing wave motion arrested, commonly grows here, the only place save the *Chamaecyparis* swamp in which this form is found around Woods Hole.

Juncus militaris Bigelow, of course, is by no means limited to this pond, but occurs rather commonly in the Woods Hole region, indeed throughout the northeastern states as well.

As other ponds both on the Elizabeth Islands and on the mainland around Woods Hole have the same fringe of *Juncus militaris* and seem, in general, to present approximately the same conditions as those described, it appeared probable that in time the fungus would be found to occur elsewhere in the region, but in spite of an interested, though intermittent, search during several seasons the species was not encountered in any other spot until last summer when in August Dr. Lewis found it not only in the same pond on Nashawena Island, but also in a somewhat similar pond, called "French Watering Place," situated on the south side of Naushon Island, the largest of this same series of Elizabeth Islands. As might have been expected, the substratum was the usual submerged and softened culms of *Juncus militaris* Big. from the marginal shallows. On carefully comparing the type with Dr. Lewis' specimens from this new locality, there is no doubt that they are indeed the same.

STRUCTURE AND DEVELOPMENT OF THE FUNGUS

The fungus, as it is seen under natural conditions on the submerged *Juncus* culms, shows small, dark, turbinate or flattened spherical fruiting bodies of varying ages and sizes occurring either singly or a few together in more or less close groupings though never fused. In position the perithecia show no polarity, nor special orientation, as they occur without any relation to gravity or the direction of light on the top, bottom, and sides of the culms (FIG. 1) as these lie more or less horizontally on each other under the water.

When examined more closely under binocular or hand lens fruiting bodies are found to show some range of size and shape in the course of their development, beginning as almost spherical initials perhaps as small as one fifth of a millimeter in diameter and becoming larger and somewhat modified in form until when mature they are usually about 1.5 to 2 mm. in diameter, and vary from slightly flattened spherical to turbinate or onion shaped. When young the perithecia are quite closed but as each matures it develops at its apex an ostiole which is rather large (20 to 30 μ in diameter) and somewhat protruding. In color they are uniformly black when young, and at maturity this tone either may remain throughout or, perhaps more commonly, may persist below while the upper portion shades into rather dark brown, the fully-formed ostiole appearing gray as the hyaline interior shows through.

As the spores are discharged they may show for a time as a grayish mass spreading out from the ostiole, whereas, after all the spores have emerged and scattered, the upper, more pallid portion of the fruiting body may disintegrate gradually until finally in old passé perithecia only the lower three quarters persists as a partly closed cup containing some fragmentary remains of the pallid content.

In texture and consistency the perithecia are not carbonaceous, but rather fleshy or perhaps gelatinously cartilaginous, and suitable staining or mounting in India ink demonstrates a thin (30 to 50 μ), rather soft, gelatinous envelope completely surrounding them.

The fruiting bodies are set upon a somewhat sparse subiculum

of black, rather thick walled, toruloid, anastomosing hyphae, which are apparently almost wholly superficial, sending only occasional colorless branches down into the substratum. In carefully cut sections, however, there may be traced an inconspicuous mycelium of fine, pale brown or gray to hyaline hyphae running down into the *Juncus* culm both between and within the cells, below the perithecium.

The structure of the mature perithecia when studied in more detail by means of free hand sections of fresh material, microtome sections of material killed, imbedded and stained, and fragments of living fruiting bodies carefully crushed and picked apart, was found to show the following features. The base of the perithecium, of much the same structure as the subiculum from which it arises, rounds up into a somewhat dome-shaped, darkened cushion, surmounted by a subhymenial region of densely interwoven, fine, hyaline ascogenous hyphae, from which grow out the asci and paraphyses in a closely packed somewhat bulging or arching cushion that practically fills the interior of the fruiting body. Surrounding this interior and closely appressed in conformity to it, there is an inner wall, a relatively thin layer of fine hyaline hyphae running for the most part longitudinally but somewhat interwoven, while exterior to this, enclosing the whole, is the outer wall of the perithecium, a dark, compact pseudotissue like that in the base, of which, indeed, it is structurally a continuation.

From the surface of this outer wall arise numerous short, slender, hyphal outgrowths which presumably may function as "mucilage hairs" and by the gelatinization of their pallid walls produce the hyaline gelatinous investment which, as already mentioned, lies as a clear zone around the outside of the perithecium. Around the ostiole some hyphae from both the hyaline inner layer and the darkened outer layer of the perithecial wall run out into a slightly protrusive circlet of pale hairs.

The content of the perithecium is involved in a clear gelatinous matrix which holds the crowded asci and paraphyses firmly imbedded together and fills the slight remaining space within the wall. As far as could be ascertained this material originates from the hyphae of the hyaline inner wall and from the

paraphyses. At first, when the perithecium is young, this matrix stains rather deeply and is apparently fairly firm, for the whole content may be pressed out in one closely cohering mass, but in time, as maturity approaches, it stains less deeply and becomes increasingly diffuse so that if mature individuals are crushed the content comes out in small, loosely adherent clumps.

The paraphyses (FIGS. 7, 8) are filiform, slightly sinuous or wavy, or somewhat bent, usually about 150 μ long (130 to 160 μ), slender, the diameter of usually 1.5 to 2 μ varying but little throughout, thin-walled, hyaline and while precise determination was difficult they were seemingly continuous although occasionally they contain here and there denser aggregations which in some cases might possibly be nuclei or more probably merely clumps of granules giving an impression of septa.

The asci (FIGS. 3, 4) are long clavate, slightly curved, and with rounded tip below which the diameter continues very nearly equal down to a little below the middle, from there tapering gradually to the somewhat sinuous, wavy base that ends in the usual angular bend at the point of attachment. In size they show relatively little variation, the length ranging from 120 to 150 μ and the greatest diameter from 8 to 11 μ.

The wall is hyaline, thin, tough, elastic, and shows no distinguishable modifications in structure or composition save that in the tip, at dehiscence, there develops a pore around which the wall persists as a firm collar (FIG. 6).

Each spore when mature consists of an irregularly spindle-shaped main body comprising two approximately equal cells somewhat constricted at the dividing septum, the distal one terminating in a bluntly rounded tip, the proximal one tapering to a long, filiform, caudate, slightly curved or sinuous appendage which projects behind (FIGS. 9, 10, 12).

The material which had been collected had not been suitably killed and fixed for an exacting, cytologic study, and when imbedded, sectioned, and stained, or crushed out, and picked apart, and stained, did not permit the determination of such cytological details as the exact orientation and behavior of the nuclei in the successive divisions to 8, the number of chromosomes

in the nuclei, and the precise activity of the kinoplasmic rays in delimiting the spores, but certain points in the formation of the spores and of their appendages could be made out. By the time that the 8 nuclei have been established by successive nuclear divisions and the 8 spores are being cut out, they are found to be closely set together, usually in two successive groups of 4 each, somewhat irregularly overlapping, in the expanded distal portion of the ascus which at this stage is short and abruptly swollen. The spores at first are uninucleate and the body of the spore is one-celled, but the nucleus divides, and the body of the spore becomes two-celled by the formation of a median cross wall. Meanwhile the ascus is elongating so that the spores become arranged seriately in the mature position mentioned later. The two-celled condition is very constant, for in the hundreds of spores, both immature and mature, which have been examined, no one-celled spores were seen and only two or three cases comprising three cells in spores of somewhat abnormal shape. As the spores are delimited and the nucleus becomes localized in the thicker distal end, this is distinguished from the very first as the body of the spore of which the appendage is an exceedingly attenuate prolongation. When the spore becomes two-celled, the appendage, as a slender continuation of the second or proximal cell of the spore body, is in no sense a separate cell and does not in its earliest demarcation possess a nucleus that later would degenerate. Rather, it is from the beginning quite without any nucleus and is but a prolongation of the second cell, a condition somewhat similar to that which has been worked out by various investigators in the spores of certain species of Podospora. The appendage is not composed merely of wall substance, but has a lumen which is exceedingly tenuous but does apparently contain substance very finely granular, homogeneous in most cases, but occasionally with larger, more obviously granular inclusions (FIG. 12), and may be cut off from the second cell of the spore body by a definite wall or may, as far as can be determined, be continuous with it, although quite distinct from it, not only in slenderness, but also in the fact that the wall substance does not form a thick capsule and the envelope of gelatinous material around the body of the spore

shows evidence of being a modification of the outer portion of the wall of this region, with quite distinct demarcation that may be detected as a flaring modification where the spore body begins, as shown in figures 9 to 12.

In size the main body of the spores was found to show such uniformity that only a few careful measurements were tabulated, the greater proportion being consistently from 17 to 22 μ long and 4 to 6 μ in diameter The appendages, however, while relatively uniform (0.5 to 0.75 μ) in diameter, show considerable variation (from 40 to 80 μ) in length, although the majority are between 50 and 65 μ long, that is, between two and one half to a little over three times as long as the spore body.

DIMENSIONS OF SPORES

Spore Body (Not Including Capsule)				Appendage	
Length		Diameter		Length	
Class μ	No. of Spores in 25	Class μ	No. of Spores in 25	Class μ	No. of Spores in 25
16–17.9	7	4–5.9	23	34–41.9	1
18–19.9	6	6–7.9	2	42–49.9	2
20–21.9	8			50–57.9	11
22–23.9	4			58–65.9	7
				66–73.9	2
				74–81.9	2

In shade the spores are consistently hyaline, with clear, rather thin wall and content, in the body cells, of a finely granular groundwork in which longer granules are scattered in more or less irregular groups, while by suitable staining a single inconspicuous nucleus can be demonstrated in the center of each cell (FIG. 10) while occasionally one or more guttulae are present (FIGS. 14, 15). The appendages are thin-walled and within the tenuous lumen the content usually appeared homogeneous although in some instances inconspicuous granular inclusions were visible here and there (FIG. 12).

Around the body of the spore there is a thick capsule or envelope of gelatinous material which is not diffluent but decidedly persistent, of definite limits, and apparently rather

firm, yet so clear that, although its presence may be assumed from the behavior of the spores and the positions they take in relation to each other when grouped, it is almost invisible, only a very faint suggestion of its outline being apparent even when especially good definition is secured. On treatment with acidulated methyl blue or methyl green, however, this gelatinous coating is differentiated clearly and can be seen to be ellipsoidal or broadly fusiform in shape, its greatest diameter of three to four times that of the spore occurring opposite the septum, the point bluntly rounded off close to the apical cell while toward the base it narrows down to the attachment of the tail-like appendage. The composition of this capsule is not homogeneous for when stained rather striking zones and radiations of decidedly contrasting depth of color stand out clearly within it (FIG. 16). The appearance of these stained capsules, especially at the juncture of the body and the appendage, gives the impression that they are gelatinous modifications around the spore body of an outer wall which continues unmodified to form the appendage.

Within the ascus, the spores lie in a series of eight, somewhat overlapping yet evenly spaced, in a rather neat arrangement in conformity to their peculiar structure and form. The body of each spore usually lies somewhat obliquely across the interior of the ascus, the basal cell of one lying alongside the apical cell of the next spore below, the eight spore bodies sometimes placed parallel to each other to form a linear series down the ascus (FIG. 4), and sometimes placed with each successive body slightly more rotated around the central axis of the ascus in a gradual spiral as in figure 3. Obviously in these arrangements the gelatinous envelope around the body of each spore is forced obliquely against those of the two adjacent, with which it is in contact, conforming to the space between them, yet not confluent with them, for even in unstained asci mounted in water slight spaces of separation (cf. FIG. 4), or faintly differentiated lines of contact (cf. FIG. 3), may be discerned. In such slight gaps a clear or very finely granular intersporal substance may be seen, while a denser, more coarsely granular material fills the base of the ascus below the series of spores (FIGS. 3, 4).

The appendages, which it should be remembered may be from

one third to even more than one half the total length of the ascus, extend down beside the spores below past the bodies of the two or perhaps three spores next in series. Held against the inner surface of the ascus wall by the tightly compressed gelatinous envelopes of these spores, the appendages may lie approximately parallel in a straight series (FIG. 4), or may be curved around in a gradual spiral as in figure 3. The appendage of the last, most basal spore, if short, may extend straight down but more commonly is doubled back on itself (FIG. 5), or compressed into a short spiral in the denser substance of the ascus base.

In occasional cases among the normal healthy spores within an ascus there occurred one or two that were shrunken, irregular or otherwise abnormal and malformed as if dead or non-functional (cf. spores 3 and 8 in FIG. 3).

As a result of the peculiarities just noted in their structure and arrangement, discharge of the spores from the ascus shows certain rather interesting features. When discharge begins the uppermost spore suddenly snaps out of the tip of the ascus through a terminal pore that is apparently the result of the softening of a small, perhaps specially modified portion of the wall, as no lid-like operculum nor any irregularly torn vent ever could be discerned. The spore does not get entirely free, however, for as it emerges the whole series of spores moves up rapidly behind it and the swollen gelatinous capsule around the body of the second spore jams at its largest diameter in the relatively narrow opening, catching the still emerging appendage of the first. As the pressure from behind continues to increase, this second spore also in its compressible gelatinous envelope is soon forced further and further through the orifice until finally it, too, suddenly snaps forth, its appendage being caught in turn as the third jerks rapidly up taking its place. This catching and ejaculation of successive spores continues at first rapidly and then more slowly as fewer spores are left in the ascus and the expulsive force of the expanding content is lessened. During discharge the expulsive substance that has emerged from the ascus with the spores continues to expand by the imbibition of water so that the column of spores, involved in this barely

discernible and ever more tenuous mass, streams slowly away from the tip of the ascus. Moreover, when free from the ascus the bent or spirally coiled appendages straighten out springily so that the spores have a most striking semblance of swimming away by the slow waving of a posterior flagellum.

From the tips of the discharging asci the stream of spores pushes its way along the scanty space beneath the arched perithecial wall and escapes through the ostiole. It should be noted that all the asci of the hymenium mature at approximately the same time, so that when discharge of spores from the perithecium begins, it continues rapidly until all the asci within have emptied themselves.

Emergence of spores from the perithecium itself begins without any external indications of dehiscence, the spores suddenly commencing to push out through the ostiole one after another and continuing, now in slow succession while but a single ascus is discharging, now more rapidly as two, three, or perhaps more ejaculate simultaneously, now slowly again while only one is active, at times ceasing for a moment, then resuming activity, the evacuation of all the spores in the perithecium requiring for its completion from twenty to perhaps forty-five minutes, depending on the size of the perithecium and the number of spores it contains.

Apparently the process of spore discharge is dependent chiefly upon the penetration of water into the perithecium to reach the mature asci within, for if ripe perithecia are adroitly punctured with the point of a very fine needle, the discharge thus induced will take place immediately through this puncture rather than through the ostiole which still may remain unopened. Or if mature but still undischarged perithecia are crushed, the clumps of asci thus forced out into the water will begin immediately to discharge their spores. Occasionally when discharge is initiated by puncturing the perithecia, or rarely during discharge as it occurs normally, whole asci will emerge, still closed but soon ejecting their spores in the usual manner while free in the surrounding water.

As far as could be determined the gelatinous envelope that surrounds the perithecium gradually softens and becomes more

diffuse in the region of the developing ostiole as the development of the perithecium goes on, until finally at maturity it becomes sufficiently permeable to permit the entrance of water that initiates discharge. The composition and structure of this gelatinous coat that at first so effectively protects the content from the surrounding water, and the nature of the changes which take place as it becomes more and more permeable until at maturity it permits water to enter, would make a most interesting micro-chemical and physiological study.

At the outset of this discharge it is obvious that the spores, in addition to their individual gelatinous encasements, are involved as well in a somewhat more diffuse gelatinous material that exudes with and around them from the ostiole in a mass that constantly increases in volume as more and more flows out. Moreover, absorption of water by this extruded material goes on rapidly so that it becomes ever more spreading and diffluent, until around the periphery, now extremely diffuse, the imbedded spores are no longer held fast. As these spores are set free thus, it becomes obvious from their behavior that they are consistently slightly heavier than water, for although no precise determination of their specific gravity was attempted, always under direct observation whether in hanging drop cultures or in Stender dishes and watch glasses, they could be seen to sink slowly through the water.

In this slow sinking the two-celled body, being of greater mass than the slender appendage, gradually takes the lead, so that the spore soon becomes oriented in its course with the body pointing downward and the slender caudate appendage trailing behind (FIGS. 9, 10). As a result of this orientation the spore comes to rest on its downward-aiming point against whatever substratum it encounters in its slow passage through the water, adhering firmly thereto by means of its gelatinous envelope. Spores thus attached may be found on *Juncus* stems and other submerged objects under natural conditions (FIG. 13), or may be caught in large numbers on slides placed beneath discharging perithecia in battery-jar cultures. When the surrounding water is made to surge actively around spores thus attached, they are not washed away but remain tenaciously

adhering by their points, while the free appendage is swayed and lashed about loosely from side to side.

After becoming attached the spores germinate without any period of rest, beginning to send out a hypha of germination in from two to perhaps five hours. Germination takes place almost invariably from the point of the attached apex of the spore (FIG. 13), for in hundreds examined only a very few cases were observed in which the germ tube had emerged from the second cell of the spore. It seems probable that this definite localization is in response to the orientation of the sinking spore and the resulting contact of the terminal cell with the substratum, for in the few exceptions noted the spores were lying in an unusual almost horizontal position that brought the second cell in contact as well.

The germ tubes grow rapidly, soon (within 30 minutes to an hour) reaching a length from one to two times that of the spore body (FIG. 17), and then sending out crooked branches which run out along the substratum and become cut off by cross walls into somewhat irregular, apparently uninucleate cells, the walls becoming thickened and rather dark (FIG. 18). It is to be noted that not only the first germ tube but also the later mycelium developing from it adheres to the substratum, or to glass surfaces, so firmly as to persist without being dislodged even by violent washing.

Although the growth of mycelia was followed for periods of one or two weeks in hanging drop cultures and ground slides until a fairly extensive mat had been established, no conidial or other types of imperfect reproduction ever were observed to take place.

The early stages in the formation of the perithecia from the beginning of the perithecial initials and possible development of ascogonia and antheridia to the formation of the ascogenous hyphae the writer has not yet had opportunity to follow in detail even though such an investigation promises some interesting results. Apparently, however, development takes place fairly abundantly and rapidly, for even in jar cultures new crops of young perithecia on *Juncus* culms under observation began to grow up within a month.

Dissemination and Persistence of the Fungus

As the fungus is known from this limited region only, it is primarily its relation to the factors of this restricted environment that is of interest. Although no accurate record has been kept, these ponds, as far as could be ascertained from members of the Marine Biological Laboratory staff who have had them and others of the region under occasional observation for the last thirty years or so, have never been known to become dry in the most severe summer droughts, nor to become frozen to more than the relatively small proportion of their depth of ten or twelve inches even in the coldest winters, so that in this time at least no provision on the part of the fungus against drying or freezing has been demanded. Moreover, while we have no exact record of how long the necessary *Juncus militaris* has been growing around the ponds, there are specimens in the M. B. L. herbarium collected as early as 1911 and the present dense stands give every evidence that the species has been established for many years.

It seems probable, therefore, that under these favorable conditions—for much more than the twelve-year period during which it has been collected from the Nashawena pond the fungus has been going through its life cycle—the spores after emergence sinking slowly head down through the water, washing about in slight currents and drifts, until some of them, reaching suitably water-soaked culms of *Juncus*, adhere by the gelatinous coating of their points and then germinate, establishing new mycelia, which give rise in time to mature perithecia of the next generation. Whether this cycle goes on uninterruptedly throughout the year has not been ascertained, but in July and August of the several years in which the fungus has been collected abundant material was found in all stages, with some perithecia, long since empty and disintegrating, others maturing, and still others just beginning to form in an abundance which would seem to indicate that, in these two months at least, the cycle is an uninterrupted one.

Here, then, at least in the Nashawena pond the relatively simple requirements of the fungus seem to be met adequately so that in this small but persistent body of water with an

abundant supply of *Juncus* culms it grows, reproduces, disseminates, and maintains itself from year to year quite successfully. Presumably, as it seems well established in the similar pond in which it was discovered last summer at French Watering Place on Naushon Island, there also the fungus maintains itself successfully.

It seems highly probable that if the fungus were spread to some of the other similar ponds of the region its requirements would be met equally well and it would thrive in these also. The most probable means by which such a transfer might be accomplished would be through spores, or possibly even perithecia, carried in mud or trash clinging to the feet or bodies of animals, especially ducks or other birds, which frequent these ponds. As this, presumably, would involve resistance to partial or complete desiccation for short periods of time at least, a few tests were made of the resistance of both separate spores and of whole perithecia. A supply of spores was secured by allowing mature perithecia to discharge in drops of water on large cover glasses; the empty perithecia were removed and the spore-filled drops allowed to dry in the shade at summer laboratory temperature, protected from dust. When treated thus each spore was found on examination to be firmly attached to the glass by its capsule which could be seen as a dense refractive envelope shrunk and hardened down around the spore body. The content in some spores treated thus developed one or two oil globules in each cell, but in others it showed no visible alteration.

After remaining dry thus for increasing lengths of time the areas of dried spores one after another were covered with drops of sterile water and the covers mounted on Van Tieghem cells, for direct observation. Under these conditions the gelatinous capsules softened, swelled and became once more scarcely discernible, although still holding at least the point of the spore firmly attached to the glass. Germination took place to the following extent: after 2, 4, 6, 8 and 10 hours' drying practically all the spores germinated vigorously; after 24 hours, about half; after 48 hours, a very few only. Apparently germination took place equally well in spores that had developed oil globules

within and spores that had remained unaltered. When, however, the drops of spores were dried on the glasses not in the shade but in direct strong sunlight it was found that, while a few germinated after five hours of such treatment, after eight or more hours' exposure apparently not one survived.

In like manner perithecia that were mature but not yet discharged were carefully removed *in toto* to cover glasses, rapidly dried, and their resistance tested. When dried they shrank to small black hardened nodules, or depressed hemispheres, that adhered firmly to the glasses, but when water was added they resumed their former size, shape and consistency and soon discharged their spores. In some cases these perithecia retained their vitality even after drying in the shade for as much as four days, not only discharging living spores which germinated normally, but sending out an extensive growth of hyphae from their bases as well.

These experiments, although few and crude, do seem to indicate that distribution of the fungus to other similar pools could indeed be accomplished through the agency of spores or perithecia carried in mud or trash adhering to the feet of birds and other animals. Moreover, although no experimental evidence was secured, it seems highly probable that spores or perithecia taken in with food or water by such animals would survive passage through the alimentary canal and be able to start growth when voided into the water of favorable ponds. Consequently, even though the fungus, as far as is known at present, appears to be limited to this restricted locality it is to be expected that it will be found elsewhere.

The Identity and Possible Relationship of the Fungus

The peculiar features of structure and development that have been considered render the identity, relationship, and systematic position of this fungus of considerable interest.

The ostiolate, non-stromatic character of the perithecia, with their dark color and general habit, would seem to claim inclusion among the non-stromatic Sphaeriales, more especially in the family Sphaeriaceae, yet the texture, being somewhat cartilaginous or fleshy and certainly never hard and carbonaceous,

might argue for insertion in the Hypocreales in spite of the dark color. On the other hand the somewhat loosely woven texture of the upper portion of the perithecial wall, its collapse when the perithecium is dried, and, after spore discharge, its disintegration in some cases until only a fragmentary, irregular base remains, might be regarded as indicating affinities with the Hemisphaeriales even though the ostiole at first is circular and sharply defined, or indeed might suggest possible affiliations with the Discomycetes.

These rather contradictory features are not easily reconciled with one another and even the most distinctive characteristics of the peculiar structure of the spores and their resulting method of emergence, distribution and attachment, do not decisively point to any particular order, while the nice conformity in structure and behavior to the obligately aquatic mode of life shows no significant similarity to that of *Vibrissea* or other aquatic forms already known. Perhaps, therefore, it is not surprising that when material was sent for diagnosis to several mycologists more familiar with this group than the writer, they returned strikingly divergent opinions varying from the Perisporiales, through the Dothidiales, Sphaeriales and Hemisphaeriales of the Pyrenomycetes to even the Discomycetes proper or to orders of rather atypical forms intermediate between these. In view of this divergence of opinion, the writer is inclined to leave the question of the precise systematic position of this fungus to be settled in the future and will be very glad to supply material to anyone wishing to make comparative study to that end.

However, whatever its true position may prove to be, the fungus seems to be one as yet undescribed, with characteristics sufficiently distinctive to oppose including it in any recognized genus, rather to justify establishing it as new. In so doing the writer feels some diffidence since in this region of the Ascomycetes he admittedly lacks the experience of long-continued investigation and the extensive knowledge of pertinent yet less common literature which, after some years' study of the submersed Phycomycetes, he realizes only too well are necessary before one gains the fundamental familiarity that justifies such

a pronouncement. Yet in the standard taxonomic authorities, even after careful search, no description or mention of any such fungus has been found, nor has it been recognized as one already known by Dr. Thaxter, by Bruce Fink, by H. M. Fitzpatrick, and by various others, familiar with the group, to whom it has been shown; or by any of the mycologists with whom it was discussed when reported in 1923 at the Cincinnati meetings of the Mycological Section.

As it seems justifiable, therefore, to establish the fungus as new, the following description is given.

DIAGNOSIS

Loramyces [1] n. g.

Nutritive mycelium of fine, slender, inconspicuously septate, almost hyaline, branching hyphae, penetrating between and within the cells of the substratum, leading to a dark subiculum of closely interwoven, anastomosing, irregularly torulose hyphae, becoming compacted into a dense pseudotissue to form the small cushion-like base of the perithecium.

No conidial or other imperfect type of reproduction observed.

Perithecia occurring on the substratum either singly or associated, though never fused, in groups, at maturity flattened spheroidal to turbinate or onion-bulb-shaped, furnished at the apex with a circular ostiole surrounded by a circlet of pallid somewhat protrusive hairs, the whole body enclosed by a clear gelatinous investment, and of a fleshy rather than carbonaceous consistency.

Hymenium comprising hyaline paraphyses, and hyaline, approximately club-shaped asci, forming a slightly arched cushion practically filling the perithecial cavity and imbedded in a clear gelatinous matrix.

Spores hyaline, with somewhat asymmetrical, approximately spindle-shaped body, surrounded by a thick gelatinous capsule, and comprising two cells, the apical one with bluntly rounded point, the basal terminating in a filiform, slightly curved, hyaline, caudal appendage.

Loramyces juncicola n. sp.

Perithecia 1/2 to 2 mm. in diameter, either black throughout or black below, shading to brownish above, with pallid ostiole 20–50 μ in diameter.

[1] This generic name, an acknowledgment regrettably all too inadequate, is given in grateful appreciation of the one who for years has been to the writer a helpful critic and a loyal ally in this and in other work.

Paraphyses hyaline, sinuous, slender, filiform, 130 to 160 μ long by 1.5 to 2 μ in diameter, with rounded tip, isodiametric to slightly tapering, thin walled, with finely granular content, apparently continuous but with denser aggregations of granules at intervals giving the impression of pseudosepta.

Asci hyaline, slightly curved, approximately club shaped, 120 to 150 μ long by 8 to 11 μ in diameter, with thin wall, and rounded apex which at dehiscence opens by a small pore.

Spores hyaline, the two-celled body mostly from 17 to 22 μ in length and 4 to 6 μ in diameter, the caudal appendage usually 50 to 65 μ in length, that is, from $2\frac{1}{2}$ to $3 \times$ the length of the body, rarely 40 to 80 μ, and from 0.5 μ to 0.75 μ in diameter. Spore body with thin wall and content finely granular with occasional denser aggregates and refractive guttulae, each cell uninucleate, the appendage thin walled and clear with occasional inconspicuous granular inclusions.

Gelatinous capsule surrounding the spore body, ellipsoidal to broadly fusiform, bluntly rounded at the point and tapering to the appendage at the base, naturally almost indistinguishably clear but on treatment with methylene blue or green showing zones and radiations of different densities.

Spores eight in an ascus arranged in a straight or slightly spiral series, the bodies overlapping part way, the appendages extending down beside the bodies of the next two or three spores below, at discharge emerging one by one from the apical pore of the ascus and passing in the swelling expulsive material through the ostiole into the surrounding water, through which they sink slowly with the appendage uppermost, the apical cell, on touching suitable substratum, adhering by the gelatinous capsule and at once sending out a hypha of germination that gives rise to the mycelium.

Saprophytic on softened culms of *Juncus militaris* Bigelow, submerged from a few inches to two or three feet in a small fresh-water pond at the eastern end of Nashawena of the Elizabeth Islands southwest of Woods Hole, Massachusetts, in July and August 1915 to 1927, and in a similar pond at French Watering Place on Naushon Island in August 1927.

Specimens and slides of the fungus have been deposited in the Farlow Herbarium of Harvard University.

POSSIBLE SIGNIFICANCE OR IMPORTANCE OF THE FUNGUS

Among the fungi, specialized aquatic forms such as this are of peculiar interest both because of their possible phylogenetic significance and because of the precision of their relation to the aquatic conditions under which they live.

With regard to the first point, if in the case of the fungi, as in the case of the phanerogams more commonly emphasized, our present land flora, according to the generally accepted view, has been derived from one living in the water, then the aquatic representatives of this group must be considered all the more significant and worthy of attention. Yet among the large numbers of fungi now known, relatively very few are aquatic, by far the most of these being included in some five orders of the Phycomycetes; while only exceedingly few, a very small number indeed, are found scattered through the main subgroups of the Ascomycetes. The aquatic Phycomycetes form a rather well-defined series with certain pronounced features which by many mycologists are considered significant indications that this series has been derived from ancestral Chlorophyceae. The aquatic Ascomycetes, however, do not as a whole seem to offer any such distinct indications of ancestral derivation, although the Laboulbeniales, which mycologically are a separate cosmos by themselves, present certain features on which is based the view deriving at least some of the present representatives of the class from the Rhodophyceae.

In the second place, the aquatic fungi are of interest because of their successful conformity in both morphological and physiological features to the peculiar submersed conditions of their environment. In this regard the submersed Phycomycetes are especially noteworthy, because of such features as their reproduction by zoöspores, but the aquatic Ascomycetes, in various features of structure and reproduction, and in various devices which accomplish distribution under aquatic conditions, also are of considerable interest.

If the fungus which has been described above is considered from the two aspects that have been mentioned it is seen to be without any apparent significance from the phylogenetic viewpoint. From the standpoint of conformity to aquatic conditions, however, it is decidedly worthy of attention. That the perithecia, developing quite submerged, remain until maturity impervious to the surrounding water which, if entering prematurely as through an injury, would cause a wholly useless expulsion of immature content, is one interesting feature. Chiefly, however,

it is the peculiarities in the structure of the spores and in their resulting method of emergence, of dissemination, of attachment and of germination, that distinguish the fungus as especially worthy of note. In these features there is a degree of specialization, a nicety of conformity to environmental conditions, and a success in survival, which, together with the fact that at present it is known only from the Elizabeth Islands, will, it is hoped, render this fungus one of more than passing interest to mycologists.

SUMMARY

The foregoing paper discusses a minute perithecial Ascomycete found growing on softened culms of *Juncus militaris* Bigelow, submerged from a few inches to two or three feet in a small freshwater pond on Nashawena Island, southwest of Woods Hole, Massachusetts, in July and August of several summers from 1915 to 1927 and in a similar pond at French Watering Place on Naushon Island in August 1927.

The morphology and reproduction of the fungus are considered, and the peculiarities in the structure, discharge, distribution, attachment and germination of the spores, in their conformity to the aquatic mode of life, are emphasized as especially noteworthy.

Certain aspects of the present limited occurrence of the organism on this restricted substratum in these small ponds are touched upon, and the possible means by which it might spread to other similar pools in the region are noted.

As the fungus, although quite distinctive, appears to be one as yet undescribed, it is established as a new genus *Loramyces* and species *L. juncicola;* the distinguishing characteristics and dimensions are given, and the possible relationships noted.

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EXPLANATION OF PLATES 8 AND 9

With the exception of figure 1, these figures were drawn by means of a camera lucida and their approximate magnifications when reduced from the originals and printed here are given, scales with 10 μ divisions accompanying them also as an absolute measure. Material stained with picro-nigrosin and mounted in dilute glycerine was used for figures 7, 8 and 9, and material stained with acid methyl green and similarly mounted for figures 15 and 16,

while the others were drawn from untreated material in water, figures 2 and 13 being from sections cut free hand mounted thus.

1. General habit of the fruiting bodies of the fungus as they appear growing on a bit of the submerged and softened culm of *Juncus militaris*. Drawn on a 10 × magnified photograph made with a Zeiss Microplanar lens, the present magnification about 5 ×.

2. General appearance of the fruiting body as seen in vertical section through the ostiole showing the thin subiculum, the rounded base, the arched subhymenium supporting the bulging hymenial layer which is closely enveloped by the hyaline inner, and dark torulose outer perithecial walls running up to a circlet of hairs around the ostiole. × 90.

3. An ascus showing the common spiral arrangement of the spores and their appendages, the line of demarcation between the appressed gelatinous capsules being faintly visible. Spores 3 and 8, as if dying, are shrunken and irregular—a condition occasionally encountered. × 1000.

4. A common type of ascus with the eight spores lying in a relatively straight series. × 1000.

5. Portion of the base of an ascus showing the eighth spore still in place with its appendage bent in a double curve as it is forced down in the narrow space against the more densely granular basal substance. × 100.

6. Portion of the tip of an ascus with a spore caught in the terminal opening, the gelatinous envelope that is holding it not being visible in the water. × 1000.

7 and 8. Paraphyses showing their characteristic shape and structure and also the granular inclusions that are differentiated by staining. × 1000.

9 and 10. Typical spores showing the characteristic form and structure, the content in figure 10 untreated, in figure 9 stained slightly to show the single nucleus in each cell. × 1300.

11. Spore of the abnormal 3-celled type rarely encountered. × 1300.

12. A typical spore, germinating, as is customary, by sending out a hypha from the point of its apical cell. × 1300.

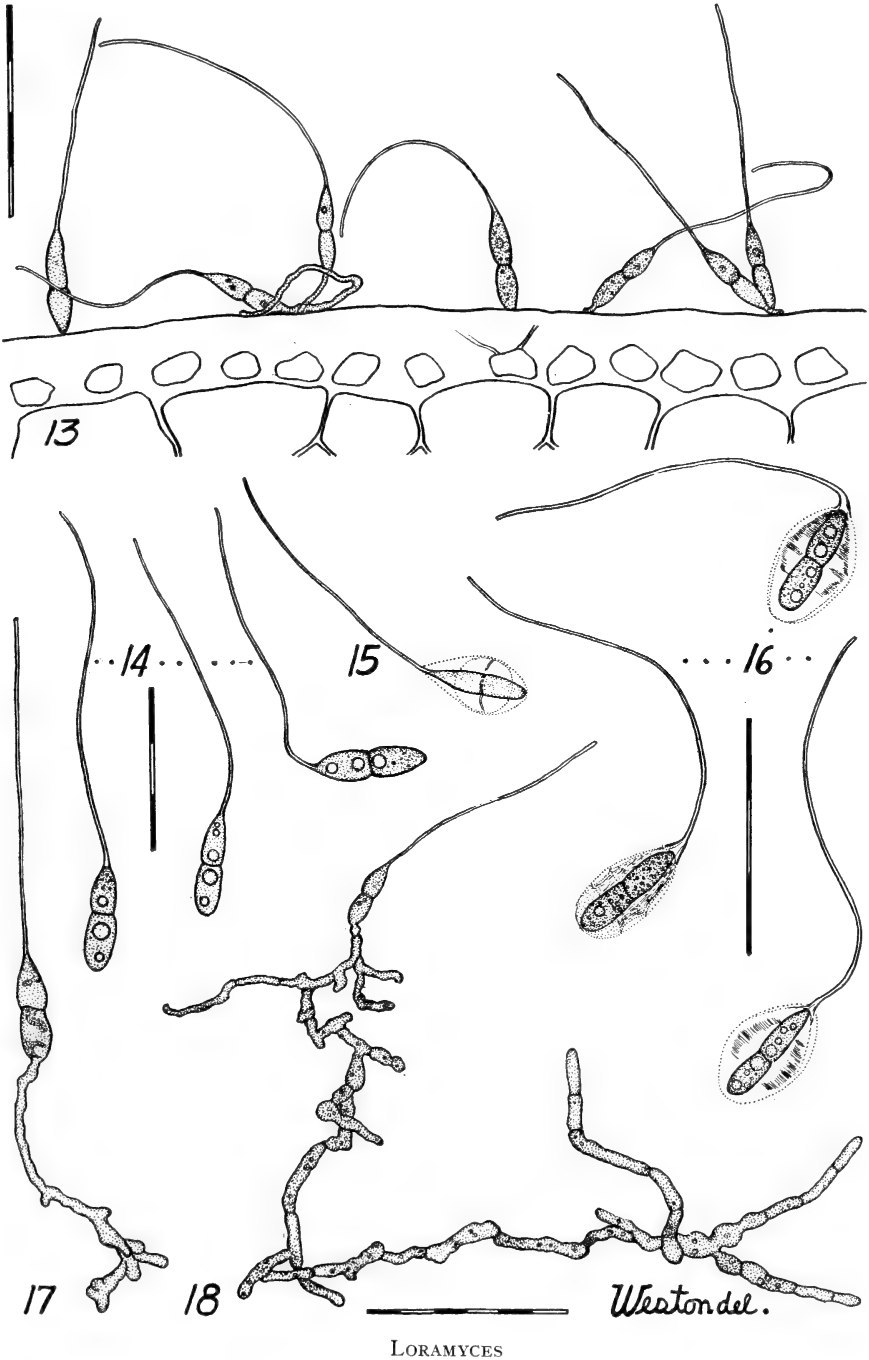
13. Portion of a cross-section cut from a *Juncus* culm that had been lying in a jar culture below discharging perithecia, showing spores that had sunk down, become attached and begun to germinate in the characteristic position. × 550.

14. Spores showing the guttulae that in some cases, especially after drying and then re-wetting, appear in the granular content. × 600.

15 and 16. Spores showing their gelatinous envelopes with the differentiated zones and striations that become visible after treatment with such stains as methyl green. 15 × 600, 16 × 800.

17. A germinating spore showing the germ tube from the apical cell just beginning to send out branches. × 600.

18. A later stage in germination showing the formation of an irregular, branched mycelium beginning. × 375.



LORAMYCES

ANOTHER FERN RUST OF THE GENUS DESMELLA

J. C. Arthur

(With 1 Text Figure)

The rusts occurring on the ferns are especially interesting due to the ancestry of the hosts and a seemingly corresponding ancestry of the accompanying rusts.

The genus *Desmella*, founded by Sydow on *Uredo Aneimiae* P. Henn., is particularly noteworthy, as it represents a very primitive form of the Pucciniaceae. Four species were recognized by Sydow (Ann. Myc. **16**: 241. 1918) at the time of establishing the genus, and one other tentatively, but thc writer considers

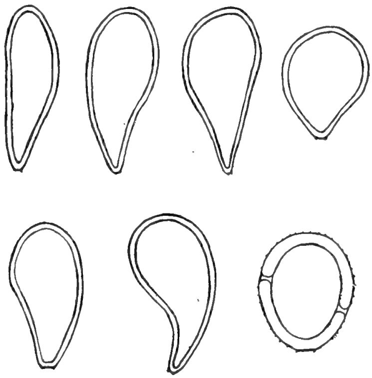


Fig. 1. *Desmella obovata*

that they are all reducible to two species: *D. mbatobiensis* (Speg.) Sydow, of which *D. Aneimiae* is a synonym, founded on a later name, and *D. superficialis* (Speg.) Sydow, with a number of synonyms. *D. mbatobiensis* is only known from South America. *D. superficialis* appears to be the most common and widely distributed member of the genus. It occurs on many genera of ferns.

Another form can now be placed in the genus *Desmella*, although only the uredinia have been seen. It is well separated

from the others by the striking shape of the urediniospores and the minuteness of their echinulation.

Desmella obovata sp. nov. Uredinia amphigenous, scattered, round, small, at first bullate and covered by the epidermis, finally pulverulent, yellow fading to white; urediniospores wedge-shape, obovate or obovate-ellipsoid, rounded above and more or less pointed below, 13–18 by 28–38 μ; wall colorless, 1–2 μ thick, very minutely and evenly echinulate, appearing smooth when wet, pores obscure.

On *Elaphoglossum latifolium* (Swartz) J. Sm., lower eastern ridge of Mossman's Peak, Jamaica, alt. 1600–1700 m., June 30, 1926, *William R. Maxon 9680* (type); same, upper eastern ridge and summit of Mossman's Peak, Jamaica, alt. 1700–1925 m., July 2, 1926, *William R. Maxon* on *E. latifolium* (Swartz) J. Sm. *9796* and *E. chartaceum* (Baker) C. Chr. *9735*.

The collections were made in the wet forest, a habitat not congenial to most rusts. A few spores were seen with evenly thick walls, about 3 μ, in which two opposite pores could be detected, which may be a resting form.

The writer feels especially grateful to Mr. Maxon, not only for the opportunity to study the material cited, but for other collections of fern rusts detected from time to time while examining his extensive collections of ferns.

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THE UREDINIA OF MELAMPSORA AND COLEOSPORIUM

E. H. Moss

(With 2 Text Figures)

A feature of considerable interest in connection with the phylogeny of the rusts is the uredinial peridium of *Melampsora*. The presence of a peridium in the uredinia of certain species of this genus was pointed out as long ago as 1899 by Klebahn (**1**) and more recently by Kursanov (**2**), by Hiratsuka (**3**) and by the writer (**4**). Whether this peridium is to be regarded as homologous with the uredinial peridium of the Pucciniastreae is an interesting question upon which fairly conclusive evidence is presented below.

Two species of *Melampsora*, namely, *M. confluens* (Pers.) Jackson on *Salix lutea*, and *M. Lini* (Ehrenb.) Lév. on *Linum usitatissimum*, have been examined. Young uredinia of the former species were carefully fixed in the field. In passing, it may be mentioned that many of the older pustules in the collections of *M. confluens* were parasitized by *Darluca Filum*. Uredinia of *M. Lini* were obtained from greenhouse cultures of this rust made by Dr. A. W. Henry. Two fixing fluids, medium chromacetic acid and formalin acetic alcohol, were used, and the preparations were stained with safranin and light green.

The mode of development of the uredinia of these species of *Melampsora* is essentially the same as has been described for *M. Medusae* (**4**). Vertical hyphae arise in palisade fashion beneath the epidermis and divide each into three enlarged cells, viz., peridial, intercalary and basal cells. The latter give rise by "budding" to spore-initials, while the intercalary cells are soon disorganized by the expansion of the spore-initials (Fig. 1). The peridial cells are commonly evanescent also, although they may persist beneath portions of the epidermis that have not been destroyed by the opening of the pustule.

A critical examination of young uredinia was made with a view to determining the mode of origin of intercalary and peridial cells. Each vertical hypha in the young sorus divides transversely to form two cells, the lower of which is a sporogenous cell, while the terminal divides to form peridial and intercalary cells. Numerous cases of conjugate nuclear division associated with the formation of peridial and intercalary cells provide conclusive evidence that these cells are sisters.

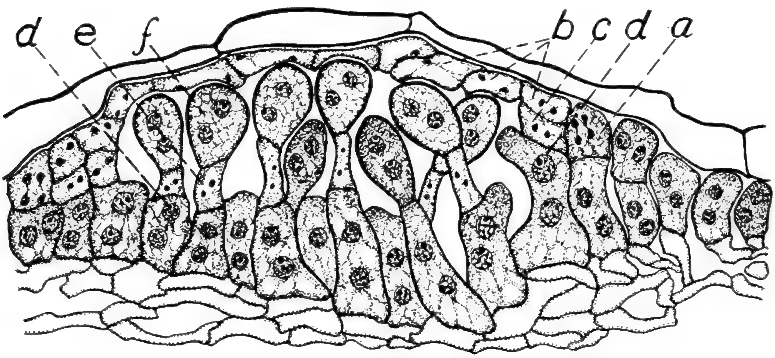

FIG. 1. Median vertical section showing early stage in development of uredinium of *Melampsora Lini:* (a) mother-cell of a peridial and an intercalary cell; (b) peridial cells; (c) intercalary cell; (d) sporogenous cell; (e) spore-stalk; (f) spore.

Therefore, the peridium of *Melampsora* may be regarded as homologous with the uredinial peridia of the Pucciniastreae (**5**) and *Cronartium Comandrae* (**4**). The writer can not agree with Kursanov's conclusion (**2**) that intercalary cells are absent in the uredinium of *Melampsora*. Also, there appears to be little evidence in support of Kursanov's suggestion that *Melampsora* is the most primitive of the Melampsoraceae.

The uredinium of *Melampsora Lini* is characterized by elongated sporogenous and stalk-cells (FIG. 1). Each stalk consists of a single cell and is not made up of two or three cells as has been described and figured by Fromme (**6**). Evidently the basal sporogenous cell was interpreted by Fromme as constituting part of the spore-stalk.

The uredinium of *Coleosporium* is said to be without a peridium, but, since a peridium occurs in the corresponding sorus of

Melampsoropsis, likewise a rust with catenulate urediniospores, a critical examination of young sori of *Coleosporium* seemed desirable.

Uredinia of *Coleosporium Solidaginis* Thüm, collected on *Solidago rugosa* Mill, were carefully fixed, embedded, sectioned and stained in the usual way. An examination of many preparations of uredinia in various early stages of development has revealed no sign of a peridium. As shown in Fig. 2, the terminal

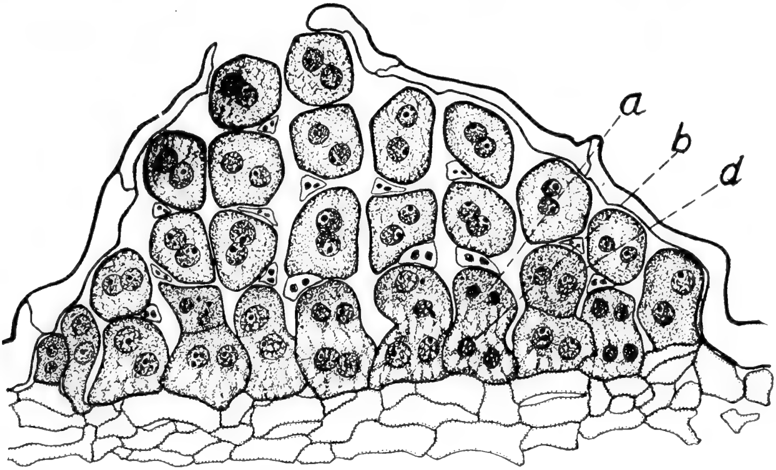

FIG. 2. A young uredinium of *Coleosporium Solidaginis* in median vertical section: (a) spore-initial 'bud'; (b) sporogenous cell; (d) spore-initial.

cells of the columns that arise in the sorus are differentiated as spores.

It is well known that the basal cells in the uredinium of *Coleosporium* give rise by basipetal abstriction to vertical rows of spores, the latter alternating with narrow intercalary cells. Spore-initials are cut off in succession from each basal cell, the spore-initial then dividing to form a spore and intercalary cell. It is a generally accepted view that the intercalary cell of *Coleosporium* is homologous with the stalk-cell of rusts whose urediniospores arise singly (not in chains). In *C. Solidaginis* the spore-initial abstricts a small intercalary or stalk cell, usually at one corner of the lower side, and at about the same time becomes detached from the new "bud" formed by the basal

cell. At an early stage the intercalary cell separates from the spore and soon disorganizes. These features are illustrated in Fig. 2 and also by Christman (**7**). This method of spore formation is in reality quite similar to that which characterizes those rusts whose urediniospores arise singly from the basal cells. In both types the spore-initials originate as a succession of buds from the basal cell, the essential difference being that in *Coleosporium* each new spore-initial buds out almost directly below the one which preceded it, whereas in the other type new spore-initials arise by lateral budding of the basal cell.

SUMMARY

A peridium is present in the uredinia of *Melampsora confluens* and *M. Lini*, as well as in *M. Medusae* already described (**4**).

Intercalary (disjunctive) cells occur in all three species.

Peridial and intercalary cells are sister cells.

The peridium of *Melampsora* may be regarded as homologous with the uredinial peridia of the Pucciniastreae (**5**) and *Cronartium Comandrae* (**4**).

There is no peridium in the uredinium of *Coleosporium Solidaginis*.

Attention is drawn to the close similarity between the method of spore formation by *C. Solidaginis* and by those rusts whose urediniospores occur singly; in both types the spore-initials arise as a succession of buds from the basal cells.

Gratitude is expressed to Professor J. C. Arthur for determining the species of *Melampsora* on *Salix* and to Dr. A. W. Henry for supplying excellent material of *M. Lini* from cultures of this rust.

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USTILAGO ECHINATA SCHROET.

D. M. Benedict

(With 1 Text Figure)

While collecting in an unpastured meadow three miles south of Chelsea, Mich., on July 19, 1927, and again on August 19, 1927, the grass, *Phalaris arundinacea* L., which is the dominant grass in this area, was found to be heavily infected with a smut identified as *Ustilago echinata* Schroet.; the identification was verified by G. P. Clinton. Its appearance was striking and

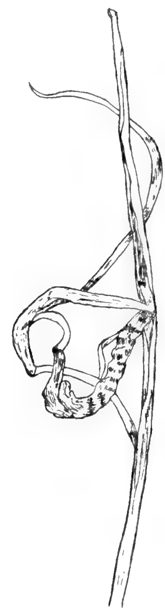

Fig. 1. Inflorescence of *Phalaris arundinacea* L. distorted by *Ustilago echinata* Schroet.

quite different from the concept one gets from the descriptions in the available literature or from the exsiccati distributed in herbaria. Culms of infected plants usually fail to develop the inflorescence which remains partially rolled in the leaf of the uppermost node with only the middle portion protruding. Increasing in length in its imprisoned situation, the inflorescence is forced to fold back upon itself and therefore pushes out laterally. The whole appears somewhat swollen, greatly twisted and

contorted, and directed more or less at right angles to the axis of the culm. The blade and leaf sheath directly inclosing the inflorescence are frequently wrinkled in longitudinally compressed folds. The characteristic smut sori appear on the hypertrophied portion and also on the leaf sheath and blade which partly inclose it. On the latter date mentioned above, the leaf blades on the lower part of the culms exhibited the characteristic sori as described for this species by Clinton in the North American Flora **7**: 1, 1910; Saccardo, Sylloge Fungorum **7**: 470; and Winter in Rab. Krypt.-Fl. **1**: 96; and as distributed in the following exsiccati: Sydow, Mycotheca Germanica no. *668*, and Brenckle, Fungi Dakotenses no. *595*. Descriptions of this species, as given in the various references cited above, make no mention of the infected and distorted inflorescence. Dr. Clinton (l.c.) gives *Ustilago Vestergreni* Sacc. & Sydow as synonymous with *Ustilago echinata* Schroet. The description of *Ustilago Vestergreni* in Sylloge Fungorum **14**: 413, 1899, states that: "Soris atrobrunneis inflorescentias nondum evolutas . . . occupantibus." The condition of the inflorescence as I have described it has been found to be a uniform and general one throughout this area where several hundred specimens were collected. It may well be suspected that this is the normal appearance when infections are caused by this fungus. The manner in which the infected inflorescence pushes out of the sheath suggests that possibly the disease may be systemic.

Inquiries made at twelve of the larger herbaria of the United States revealed no specimens showing a distorted inflorescence. This may be due to the fact that the flatly pressed leaf blades make a neater packet than the swollen and clumsy flower heads. The same inquiry also shows that American collections are reported from very few localities. Places from which specimens have been collected and distributed are Bingen, state of Washington, and Northville, South Dakota. Clinton (l.c.) reports its occurrence in Nebraska and Washington. This Michigan collection would seem to extend the known range of *Ustilago echinata* Schroet. considerably, possibly being the first record east of the Mississippi River.

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STUDIES OF THE SEDGE RUST, PUCCINIA CARICIS-SHEPHERDIAE

W. P. Fraser and G. A. Ledingham

(With Plate 10)

An *Aecidium* on *Lepargyraea canadensis* (L.) Greene [*Shepherdia canadensis* (L.) Nutt.] collected at Buffalo, N. Y., was described as *Aecidium Allenii* by Clinton (Ann. Rept. N. Y. State Museum **24**: 93. 1872). Davis (Trans. Wis. Acad. Sci. **21**: 299. 1924) described culture experiments, from which he concluded that *Aecidium Allenii* on *Lepargyraea canadensis* was connected with telia on *Carex eburnea* Boott. He described the rust as *Puccinia Caricis-Shepherdiae.* Arthur (North Am. Flora **7**: 785) places this rust under *Dicaeoma Allenii* and records aecia on *Lepargyraea canadensis* and *L. argentea* (Nutt.) Greene and telia on *Carex viridula* Michx. and *Carex eburnea.* The senior author (Mycologia **17**: 82. 1925) reported unsuccessful inoculations of a number of grasses with the aeciospores of *Aecidium Allenii* Clinton from *Lepargyraea argentea.*

An *Aecidium* of the type of *Aecidium Allenii* was found to be very common in Northern Saskatchewan on species of the family Elaeagnaceae. A field study was made to determine its telial relationship. This study suggested the connection of the aecia on *Elaeagnus commutata* with telia on *Carex lanuginosa* Michx. In 1925 inoculations were made in the greenhouse on *Carex lanuginosa* with aeciospores collected at Saskatoon on *Elaeagnus commutata.* Infection followed with a marked development of telia.

In 1926 inoculations were made on *Elaeagnus commutata*, *E. angustifolia*, *Lepargyraea canadensis* and *L. argentea* with germinating teliospores from *Carex lanuginosa* collected at Saskatoon. Pycnia developed abundantly on all the shrubs and aecia on all except on *L. canadensis.* The experiments were repeated with like results. The plants of *L. canadensis* were in a flourishing condition, so the failure to develop aecia was not due

to lack of vigor of the host. Aecia were collected on all of these shrubs at Saskatoon and inoculations were made on *Carex lanuginosa*. Uredinia and telia developed in every case, except when aecia from *L. canadensis* were used. Then no infection followed.

The inoculations were continued in 1927 using teliospores collected at Saskatoon on *Carex lanuginosa* and *C. aquatilis* with the same results as in 1926. Telia from *C. aquatilis* Wahl. collected at North Battleford, about one hundred miles distant from Saskatoon, gave infection on all shrubs used in 1926 including *L. canadensis*, with abundant development of pycnia and aecia. The experiments were repeated using teliospores from *Carex lanuginosa* collected at North Battleford and pycnia and aecia developed abundantly.

Teliospores on *Carex atherodes* Spreng. collected at Saskatoon infected *Elaeagnus commutata* with the development of uredinia and telia. Aeciospores from *Elaeagnus commutata* also gave slight infection on *Carex Sprengelii* with sparing development of telia.

The telial stage of this rust was found to be very common in Northern Saskatchewan on *Carex lanuginosa* and *Carex aquatilis*. A few collections were made on *Carex atherodes*. The uredinial stage was only sparingly developed in the greenhouse cultures and also in the field collections. The aecial stage is also very common on the native shrubs *Elaeagnus commutata*, *Lepargyraea canadensis* and *L. argentea*, and on the Russian Olive (*Elaeagnus angustifolia*), an introduced shrub frequently planted in hedges. In wet seasons hedges of this plant are partially defoliated. From these experiments *Lepargyraea canadensis* does not seem as congenial a host as the other shrubs. The different results obtained from inoculations with teliospores obtained at Saskatoon and North Battleford may indicate that there are biologic forms with different reactions on *L. canadensis*.

A morphological study was made of the various spore forms. The aecia usually occupy large areas of the leaf: the pycnia are prominent and usually arranged in a stellate manner. These characters easily distinguish them from *Puccinia coronata*, which also occurs on some of these shrubs. There was a close agreement

with Arthur's description in the North American Flora, except that the aeciospores averaged a few microns larger and pycnia were always present in our field collections and in cultures and usually rather conspicuous. Arthur in the N. A. Fl. states the pycnia are "few or none." Arthur (Bull. Torrey Club **47**: 477. 1920) described an *Aecidium* on *E. angustifolia* as *Aecidium arctoum*. From this study it seems this form should be assigned to *Puccinia Caricis-Shepherdiae*.

Through the courtesy of Mr. House of the New York State Museum, we were able to examine part of the type of *Aecidium Allenii*. The aecia were similar to those studied and here assigned to *Puccinia Caricis-Shepherdiae*. Collections made on *Lepargyraea canadensis* and *Carex eburnea* by Dr. J. J. Davis in Wisconsin, and by Prof. J. Dearness in Ontario, were also examined and found to agree with the Saskatchewan material.

Collections of aecia on *Elaeagnus commutata* were also made at Morrin, Alberta, and in Northern and Southern Manitoba by Mr. E. Criddle on *Lepargyraea canadensis*, so that it is probable this rust is widely distributed in the Prairie Provinces of Canada.

SUMMARY

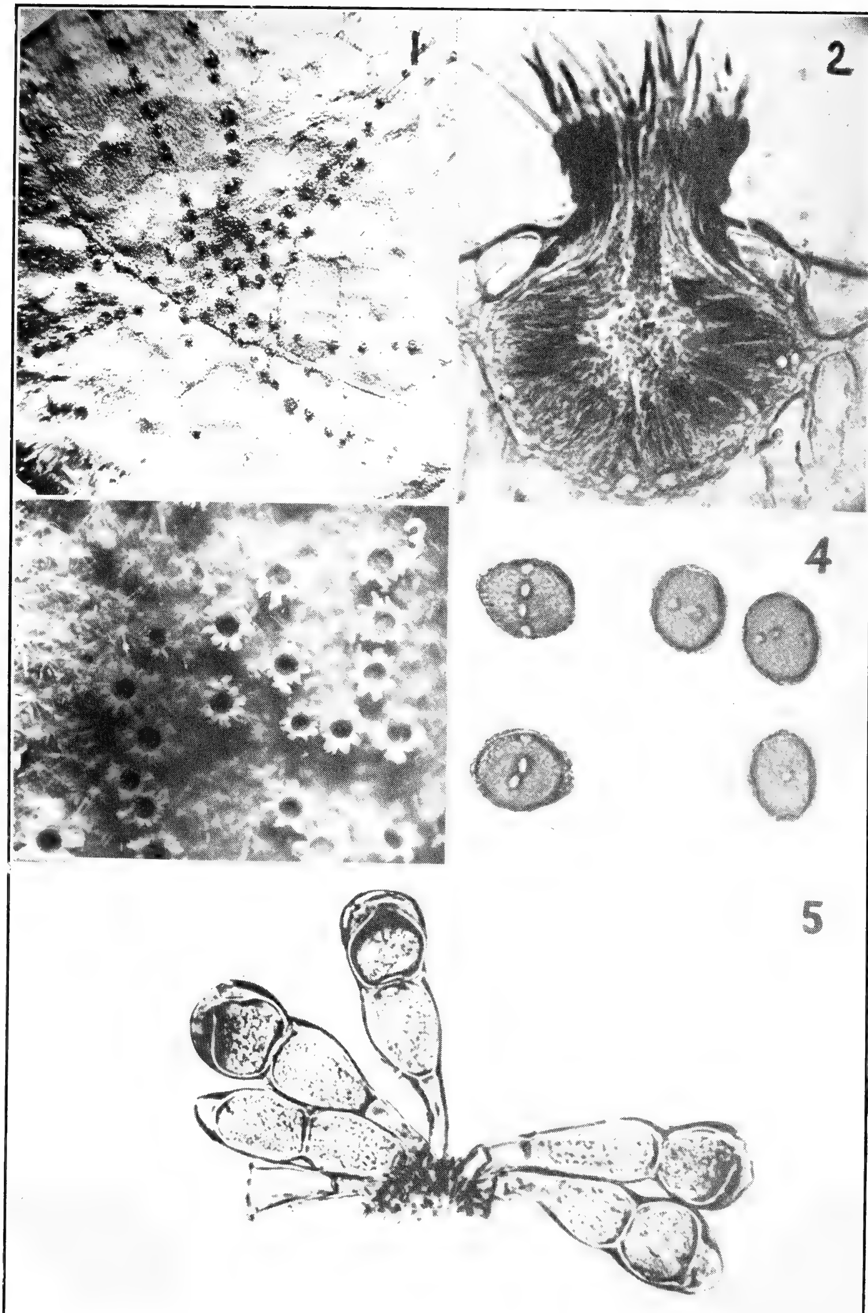
Inoculations with teliospores of *P. Caricis-Shepherdiae* on *Carex lanuginosa* and *Carex aquatilis* produced pycnia and aecia on *Elaeagnus commutata*, *E. angustifolia*, *Lepargyraea argentea* and *L. canadensis*.

Inoculations with aeciospores from *Elaeagnus commutata*, *E. angustifolia*, *Lepargyraea argentea* and *L. canadensis* produced uredinia and telia on *Carex lanuginosa* and *Carex aquatilis*.

A few collections of teliospores of *P. Caricis-Shepherdiae* on *Carex lanuginosa* produced pycnia on *L. canadensis* but failed to produce aecia, though producing normal infection in the other shrubs named in the preceding paragraph. This may indicate biologic forms.

Aecidium arctoum on *Elaeagnus angustifolia* and *Aecidium Allenii* on *Elaeagnus commutata*, *Lepargyraea canadensis* and *L. argentea* are from these studies assigned to *Puccinia Caricis-Shepherdiae*.

The writers wish to acknowledge the aid of Mrs. Bernhard



PUCCINIA CARICIS-SHEPHERDIAE

Nebel (*née* Mabel L. Ruttle) in making field observations and in culture work in the greenhouse. They also wish to gratefully acknowledge the courtesy of Mr. House of the New York State Museum, Dr. J. J. Davis and Dr. Dearness for supplying material as mentioned in the paper.

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Explanation of Plate 10

Fig. 1. Pycnia on leaf of *Lepargyraea canadensis* showing stellate arrangement (× 60).

Fig. 2. Section through pycnium on leaf of *Lepargyraea canadensis* (× 275).

Fig. 3. Aecia on leaf of *Elaeagnus angustifolia* (× 25).

Fig. 4. Urediniospores showing equatorial arrangement of germ pores, collected on *Carex aquatilis* (× 375).

Fig. 5. Teliospores on *Carex lanuginosa* (× 500).

A NOTE ON THE OCCURRENCE OF TWO ROTIFER-CAPTURING PHYCOMYCETES

F. K. Sparrow, Jr.

(With 1 Text Figure)

Although many fungi are known to parasitize various animals, the type of parasitism that involves the capturing and killing of actively moving prey of disproportionately large bulk by minute fungi which then consume the victim seems, as far as at present known, to be restricted to a few forms. The two striking examples of this mode of life are *Zoophagus insidians* Som. and *Sommerstorffia spinosa* Arn., filamentous aquatic Phycomycetes, which have been described in recent years as capturing members of the Rotiferae. Apparently, these two fungi are somewhat limited in their distribution, *Zoophagus* having been heretofore reported from seven localities situated in Styria, Bulgaria, Germany, France, Croatia and the Eastern United States, while *Sommerstorffia*, up to the present writing, has never been reported, as far as could be ascertained, since its discovery in Bulgaria.

The writer has had the good fortune during the past year to find and to observe these two interesting fungi and, in view of the fact that their parasitism is of such an unusual type and that references to them in the literature are so few, the presentation of this brief note concerning them seems justifiable.

Sommerstorffia spinosa Arn. was observed by the writer in March, 1927, while examining a laboratory culture of *Rhizoclonium* sp. (?), collected in a small pond in Fresh Pond Parkway, Cambridge, Mass., October 20, 1926, capturing members of the genus *Monostyla*. The American material, in general, resembled closely the description of Arnaudow (**2**) and, as we have only this author's account of the organism, it seems desirable to include here some of the main features of the fungus as shown by this material.

The primary mycelium of the fungus, in this American material, was not extensively developed, being limited to three to

five short, slightly tapering branches which exhibited a tendency to encircle the algal filament in a manner suggesting an epiphytic association with the *Rhizoclonium* (FIG. 1). The hyphae were, with the exception of their tips, practically isodiametric, non-septate and from 4–6 μ in diameter. Except where attached for a time to the body of the rotifer, the tip of each hypha was constricted and elongated to form a spike-like structure of varying length (FIG. 1). It is by means of these structures that the rotifers are captured, for, according to Arnaudow, their tips

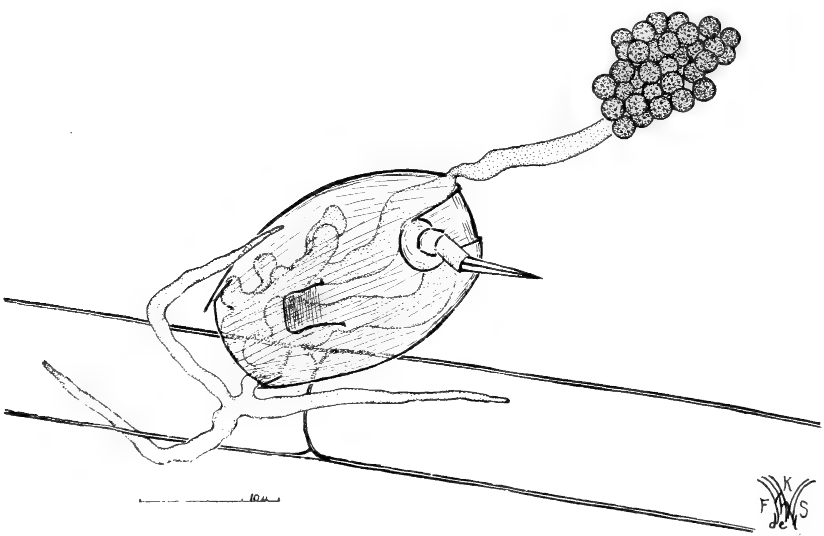

FIG. 1. Habit drawing of *Sommerstorffia spinosa* Arn. epiphytic upon a portion of a filament of *Rhizoclonium* sp. (?), showing the primary mycelium clasping the alga and bearing projecting attenuated points, an attached rotifer within which the contorted feeding hyphae are visible, and an evacuation tube emerging from the posterior region of the animal and bearing at its apex an irregular mass of encysted zoospores. The content of the alga is not shown but was normal. The drawing was made with the aid of the camera lucida from material mounted in glycerine and eosine. $\times$ 500.

excrete a sticky, mucilaginous substance to which the passing rotifer becomes stuck, usually in the region of the mouth. Once captured in this manner, the animal, in spite of all its efforts to escape, is held fast, dies, and its body is soon invaded by the mycelium of the fungus, which, growing in through the mouth, completely fills the soft interior and consumes all but the chitinous

outer shell. The American material showed several cases of rotifers captured and devoured in this manner.

The mycelium which develops within the rotifer presents a swollen, distorted and sacular appearance (FIG. 1) with hyphae from 5–8 μ in diameter, which have a few lateral branches of varying length. These branches, in contrast to the primary hyphae, do not produce specialized tips and have no differentiation of their end walls.

Non-sexual reproduction in *Sommerstorffia* is by means of zoöspores and in the American material this phase was well developed. Preceding their formation there developed from the mycelium within the rotifer an elongate, isodiametric evacuation tube which extended, after a marked constriction of its diameter, from the posterior region of the shell about 54 μ out into the water (FIG. 1). Although the writer was only fortunate enough to observe the discharge of the last zoöspore from the mouth of the sporangium, the process was apparently the same as that described by Arnaudow. After emergence, the zoöspores rounded off, encysted, and formed an irregular, motionless group at the apex of the sporangium (FIG. 1). The encysted zoöspores were 7.2 μ in diameter, which was less than the 10 μ described by Arnaudow, a discrepancy which possibly may have been due in part to shrinkage in glycerine before measurements were taken. Emergence of a biciliate zoöspore from each of these cysts was observed by Arnaudow and presumably would occur here also, although it was not seen by the writer.

Reproduction by means of oögonia and oöspores was described by Arnaudow but was not found in the present material. According to Arnaudow the oögonia were characterized by the possession of blunt, irregular projections on their walls and, as no antheridia were observed, he concluded that the fungus was apandrous. The oögonium when mature contained one smooth walled oöspore which was described as up to 22 μ in diameter. Germination of the oöspore was not observed. No further points of importance in the life history were described by Arnaudow nor did the scanty material of the writer afford such an opportunity. Although no oögonia or oöspores were observed by the author, the very characteristic vegetative condition of

the fungus, as well as its non-sexual reproductive structures, identified the organism with certainty.

Zoophagus insidians Som., the second of these rotifer-capturing fungi, was found by the writer in March, 1928, in a laboratory culture containing *Nitella* sp. (?) and several members of the Chlorophyceae, collected in September, 1927, by Mr. Hollis Webster in Maine.

This fungus is characterized at once by the occurrence along the entire length of its mycelium of short, blunt, peg-like lateral branches of varying length, which arise at right angles to the main filament. The mycelium is non-septate, isodiametric and, in contrast to *Sommerstorffia*, is extensively developed. Although it ramifies freely throughout the algal filaments in the culture, no definite epiphytic relationship with these organisms, such as occurred in *Sommerstorffia*, has been noticed. The method of capturing the rotifer, however, is similar to that previously described for *Sommerstorffia*, the tips of the peg-like lateral branches exuding a sticky substance which holds the rotifer fast until penetration by the hypha is effected.

Arnaudow (**1**) (**3**), who has investigated in detail the life history of *Zoophagus*, found that slender, fusiform gemmae were produced by the mycelium, which, upon germination, gave rise to the typical vegetative mycelium. The non-sexual reproduction of *Zoophagus*, as described by this investigator, is similar to that found among the members of the section *Aphragmium* of the genus *Pythium* since, as in this group of fungi, the undifferentiated protoplasm is discharged from a filamentous sporangium into a vesicle, situated at the apex of this former structure, and is there cleaved into zoöspores. The zoöspores in *Zoophagus* were found to be diplanetic. It was further observed that the fungus was heterothallic and that the anastomosing of a plus and minus mycelium was necessary for the production of sexual organs. No measurements of the oögonia, antheridia, or mature oöspores were given by Arnaudow. Not all these details were observed in the American material, but enough to make the identity of the fungus absolutely certain.

From the standpoint of their aquatic habitat, in a surface relation to algae, their general morphology and life history and

especially their mode of parasitism, these two forms seem intimately related. But when their broader relationships are considered, it is obvious that they show general similarities to two different groups of fungi.

Sommerstorffia is clearly a member of the Saprolegniales and of this group it more nearly approaches the genus *Aphanomyces*. The irregular protuberances on the oögonium wall are similar to those found in *Aphanomyces stellatus* deBary, while in its habitat it recalls *Aphanomyces phycophilus* deBary, a form thus far found only as a parasite of *Spirogyra* and *Zygnema*. The swollen and distorted intramatrical mycelium, so characteristic a feature of *Sommerstorffia*, is simulated in a closely related form, *Aphanomycopsis*, a genus recently described by Scherffel (6) as parasitic on several members of the Diatomeae. It differs from all of these, however, in its mode of parasitism and apandrous oöspores. The writer's conclusions as to the position of *Sommerstorffia* among the Phycomycetes are in entire agreement with those of Arnaudow, who placed the fungus in the Saprolegniaceae near the genus *Aphanomyces*.

Zoophagus, on the other hand, seems to be closely allied to the group of aquatic and semi-aquatic fungi placed in the section *Aphragmium* of the genus *Pythium*. The production of gemmae, regularly found in *Zoophagus*, has not, however, been reported as occurring in any members of the Aphragmia found thus far. The occurrence in *Zoophagus*, which possesses sexual and non-sexual reproductive organs similar to those of *Pythium*, of a typical saprolegniaceous structure, the gemma, has suggested to Arnaudow the possibility that *Zoophagus* may be a connecting link between these two groups of organisms. Most of the species of the Aphragmia, however, have been scarcely more than described and, until they have been subjected to conditions similar to those of *Zoophagus*, we cannot be sure that they also will not produce gemmae. It is further possible that in the future forms will be found which will more nearly bridge the wide differences in the process of zoöspore formation between the two orders.

As presented in the literature, both *Sommerstorffia* and *Zoophagus* appear to be rather limited in their distribution.

Sommerstorffia was first found near the village of Dragitschewo in the vicinity of Sophia, Bulgaria, in 1923 by N. Arnaudow (**2**). It was there observed capturing members of the genus *Monostyla* and was described by its discoverer as "zwar epiphytisch auf *Cladophora*." Up to the present time, so far as the writer has been able to determine, the fungus has not since been observed.

Judging from the frequency of its occurrence in the literature, *Zoophagus* is apparently more common than *Sommerstorffia*. The former fungus was discovered and described in 1911 by H. Sommerstorff (**7**), who found it in a culture of *Cladophora* and *Spirogyra* collected in the vicinity of Gratweni in Styria. It was next reported by Arnaudow (**1**), who found it in 1913 among filaments of *Oedogonium* and *Bulbochaete*, collected in the environs of Sophia, Bulgaria, and again in 1925 near Munich, Germany (**3**). *Zoophagus* was further reported from France (**5**) (1920) by Mirande and from Croatia (**4**) (1922) by Gicklhorn. The only report of the fungus from the United States appears to be that of Weston (1923), who, in a short paper delivered before the mycological section of the Botanical Society of America at the Cincinnati meeting in 1923, described the occurrence of the fungus in a culture of algae maintained for some years in the cryptogamic laboratories of Harvard University. Slides of this material, as well as others of the same fungus collected by Professor Weston at Great Barrington, Massachusetts, have been examined by the writer and have been found to agree in every respect with the Maine specimens.

It seems evident that these exceedingly unusual forms will, upon intensive search, be found to be much more widely distributed than has hitherto been supposed and it is hoped in the future that further investigation will add much to our knowledge of this group of rotifer-capturing parasites.

In conclusion, the writer wishes to thank Professor Weston for his kind aid and criticism in the preparation of this note and for his assistance in making the plate.

CRYPTOGAMIC LABORATORIES OF HARVARD UNIVERSITY

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CONTRIBUTION TO OUR KNOWLEDGE OF OREGON FUNGI—III [1]

S. M. Zeller

(With 3 Text Figures)

BASIDIOMYCETES

Family 1. Uredinaceae

1. Gymnoconia interstitialis (Schl.) Lag.

On Kittatinny blackberry, Salem. Infrequent. May. No. *6927.*

Family 2. Clavariaceae

2. Clavaria rugosa Bulliard.

In wood lot, Corvallis. December. Frequent. No. *2076.*

3. Clavaria myceliosa Peck.

In coniferous woods, Corvallis. October to November. Frequent. No. *2032.*

4. Clavaria formosa Fries.

In coniferous and mixed woods, Corvallis and Blue River. October to November. Nos. *2158*, *2407*.

Branches wrinkled, blunt, dichotomous above, light ochraceous-buff to light ochraceous-salmon, turning deep vinaceous in all parts when bruised.

5. **Clavaria occidentalis** n. sp.

Fructifications simple or seldom once-forked, single or caespitose, narrowly clavate, often flattened with longitudinal furrows on larger plants, up to 15 cm. long and 4 to 8 mm. broad, Rood's brown when fresh, drying wood brown, concolorous throughout except whitish at base in larger plants; odor pleasant, taste slightly acrid; flesh white; internal structure in central portion hollow to stuffed with meshy strands of filaments, gradually passing to a subhymenial layer of soft pseudoparenchyma; basidia subcylindrical to clavate, 55–74 × 7–9 μ, 2–4-spored; spores ellipsoidal to inequilateral, hyaline, granular, one-guttulate, asperu-

[1] Continuation of mycological notes. Mycologia **19**: 130. 1927.

late, 6–8 × 3–4 μ. Spore print white. Cystidia few, hyaline, conic above hymenium, projecting 37–52 μ, sometimes encrusted and gloeocystidia-like. (FIG. 1.)

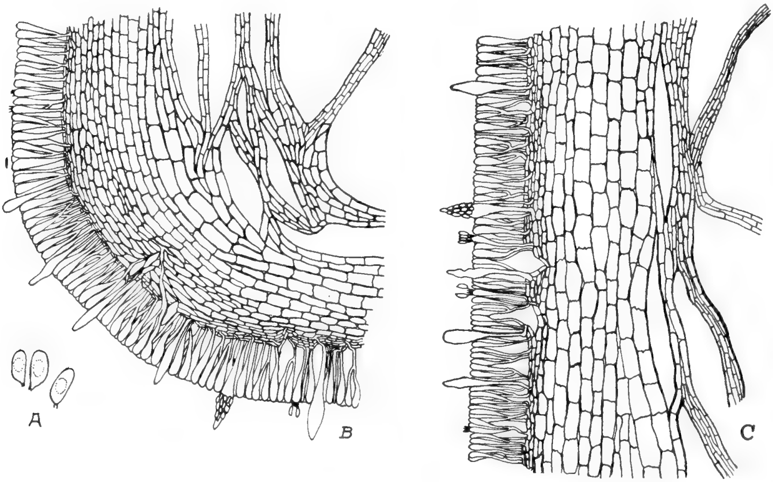

FIG. 1. *Clavaria occidentalis* Zeller. A. Ascospores. × 600. B and C, respectively, cross and longitudinal sections of hymenium and underlying tissue. × 100.

On humus among mosses, Waldport. December. (Type in Zeller Herb., *7185*, and in Ore. Agr. Coll. Herb., *4935*.)

Clavaria occidentalis bears a close relationship with *C. incarnata* Weinm., *C. purpurea* Fr. and *C. rosea* Fr. from all of which it differs in the slightly rough spores and size of basidia.

Family 3. THELEPHORACEAE

6. CRATERELLUS CORNUCOPIOIDES (L.) Pers.

Among mosses and *Rhus diversiloba*, Corvallis. November. No. *7146*.

This collection extends the reported range of this species from Missouri to the Pacific Coast.

7. STEREUM CHAILLETII Pers.

On a coniferous wood, Devil's Lake, Tillamook County, and Corvallis. Infrequent. July and November. Collected by Epling Nos. *167* and *765*.

8. STEREUM CINERASCENS (Schw.) Massee.

On *Ulmus*, Corvallis. October. Infrequent. No. *6881*.

9. STEREUM ERUMPENS Burt.

On apple, Corvallis. March. Frequent. No. *2087*.

Previously reported from Grants Pass in this State. This is the most common Thelephore on pomaceous fruit trees in the Pacific Northwest.

10. STEREUM MURRAYI (Berk. & Curt.) Burt.

On oak, Hood River. April. Infrequent. No. *6908*.

First report of this species from Oregon.

11. STEREUM RUGISPORUM (Ellis & Ev.) Burt.

On *Picea*, Crater Lake National Park and Waterville.

Collected by Epling and Shoret. Epling Nos. *641*, *835*.

12. STEREUM SANGUINOLENTUM Alb. & Schw.

On *Pseudotsuga*, Corvallis. October. Infrequent. No. *6880*.

13. STEREUM SUBPILEATUM Berk. & Curt.

On *Quercus garyana*, Corvallis. Infrequent. October. No. *6882*.

This perennial *Stereum* has been previously reported from Jasper, Texas, in the Southwest, but its occurrence in Oregon greatly extends its known western range in the Northern United States.

14. CORTICIUM CENTRIFUGUM Lév.

On *Pseudotsuga taxifolia*, Corvallis. September. Frequent. No. *2066*.

15. CORTICIUM EVOLVENS Fries.

On willow, Corvallis. Infrequent. November. Collected by Epling. No. *719*.

16. CORTICIUM LIVIDUM Pers.

On decorticated log in mixed woods. Philomath. November. No. *2159*.

17. CYPHELLA FASCICULATA (Schw.) Berk. & Curt.

On *Alnus* twigs, Corvallis. November. Epling No. *432*. Zeller No. *2623*.

This is the first report of this species west of Wisconsin.

18. SOLENIA ANOMALA (Pers.) Fries.

On dead wood, Corvallis. April. No. *2573*.

19. ALEURODISCUS CANDIDUS (Schw.) Burt.

On oak, Corvallis. December. Infrequent. No. *1990*.

20. ALEURODISCUS PENICILLATUS Burt.

On hemlock, Corvallis. May. No. *1951*.

This collection was taken within 40 miles of the type locality (Eugene) of this species.

21. HYPOCHNUS PALLESCENS (Schw.) Burt.

On *Pseudotsuga*, Corvallis. Infrequent. May. No. *6885.*

Except *H. echinosporus* (Ellis) Burt, this is the only report of this genus from Oregon.

Family 4. HYDNACEAE

22. HYDNUM IMBRICATUM (L.) Fries.

In coniferous woods, east slope of Mt. Hood, Hood River County. October. Infrequent. No. *6931.*

This collection was made by Dr. L. F. Henderson, who says the specimen weighed 6 lbs.

23. PHLEBIA CINNABARINA Schw.

On *Alnus*, *Quercus* and *Abies*, Corvallis and Cascadia. September to November. Frequent. Nos. *1973*, *1976*, *2011.*

24. PHLEBIA RADICATA Fries.

On *Tsuga heterophylla*, Philomath. November. Frequent. No. *2160.*

Family 5. BOLETACEAE

25. BOLETUS EDULIS Fries.

In sandy soil, Newport. August. No. *2465.*

26. BOLETUS SUBTOMENTOSUS (L.) Fries.

Subalpine to alpine, Mt. Hood. October. No. *2553.*

This collection was made by L. F. Henderson and has a deeply rimose cap, 20 cm. broad.

27. BOLETINUS PICTUS Peck.

Hood River County. October. Frequent. No. *6935.*

Collected by L. F. Henderson. No. *12.*

Family 6. POLYPORACEAE

28. FOMES RIBIS (Schum.) Gill.

On cultivated currant, Corvallis. January. No. *2486.*

Apparently doing very little damage.

29. POLYPORUS BERKELEYI Fries.

On oak stump, Benton County. November. No. *2400.*

30. POLYPORUS CRISPUS (Pers.) Fries.

On hard wood, Corvallis and Blue River. Infrequent. March. Epling Nos. *351* and *657.*

31. POLYPORUS CUNEATUS Murrill.

Blue River, March. Coll. C. C. Epling. Infrequent. No. *2314*.

32. POLYPORUS DELECTANS Peck.

On oak, Corvallis. December. No. *2281*.

33. POLYPORUS DIATORTUS (Schw.).

From old apple stump, Eagle Point. September. Infrequent. No. *7161*.

34. POLYPORUS EPILEUCUS Fries.

On oak, Corvallis. December. Infrequent. No. *2280*.

35. POLYPORUS FUMOSUS (Pers.) Fries.

On decayed wood, Corvallis. November. No. *2418a*.

36. POLYPORUS GUTTULATUS Peck.

On oak (?), Corvallis. September. No. *2414*.

37. PORIA AMBIGUA Bres.

On oak stump, Corvallis. March. Nos. *2278*, *2282*.

38. PORIA CARBONARIA Berk. & Curt.

Blue River. March. No. *2354*.

39. PORIA FERRUGINOSA Fries.

Corvallis. November. No. *2332*.

40. PORIA INCRASSATA (Berk. & Curt.) Burt.

On fir flooring in basements and on girders under dwellings, Corvallis and Multnomah. September to January. Nos. *2410*, *2411*, *2412*, *2413*, *2408*.

41. PORIA INCRUSTANS (Berk. & Curt.).

In lawns, Hillsboro, and choking out alfalfa, Eagle Point. May. Nos. *2538*, *7106*.

42. PORIA MUCIDA Pers.

On oak, Corvallis. October. No. *2020*.

43. PORIA VAILLANTII Fries.

On fir wood in Greenhouse, Corvallis. December. Frequent. No. *7029*.

44. TRAMETES BENZOINA Fries.

On *Abies grandis*, Corvallis. November. Infrequent. No. *2375*.

45. TRAMETES MOLLIS (Sommerfeld) Fries.

On moss-covered log, Corvallis. April. (Epling 705) No. *2296*.

46. TRAMETES TENUIS Karst.

On charred coniferous wood, Waltersville. March. Infrequent. (Epling 584) No. *2310*.

47. MERULIUS AMERICANUS Burt.

On block of *Pseudotsuga taxifolia*, in a cellar and on stumps of same host in woods, Corvallis and Philomath. November. Nos. *2161*, *2162*.

This is the first report of this species west of the Rocky Mts.

48. MERULIUS CORIUM Fries.

On *Cytisus scoparius*, Corvallis. May. Infrequent. No. *6941*.

Collected by H. P. Barss.

49. MERULIUS FUGAX Fries.

On Douglas fir, Corvallis. September. Infrequent. No. *2065*.

50. MERULIUS NIVEUS Fries.

On *Alnus*, Corvallis. December. Infrequent. No. *1992*.

Not previously reported from the Pacific Coast States.

Family 7. AGARICACEAE

51. AMANITA CALYPTRODERMA Atk. & Ballen.

In open woods, Corvallis. April and in the Fall. Frequent. No. *6904*.

Large plants were brought in by Dr. H. M. Gilkey in April. These plants were 16–20 cm. high and the caps were 12–14 cm. in diameter. Morphologically they were typical but cystidia were found very scatteringly. These are obovate, smooth, 18–25 × 12–15 μ.

52. AMANITA PANTHERINA Fries.

In coniferous wood, Corvallis. April. Frequent. No. *6905*.

A collection of this species was brought in by Dr. Helen Gilkey and I believe it is the first report of the species from North America. The plants in every way fulfil the description of *A. pantherina* as given by Ricken. The basidia are 45–50 × 10–12 μ and the spores are ellipsoidal with characteristically blunt ends. The white remains of the volva are left irregularly in small patches on the pileus. On some plants, they are rather sparingly scattered, as illustrated by Ricken. Unfortunately the writer

does not have at hand authentic material of *A. pantherinoides* Murrill but, from description, this is distinct. In this the spores are larger, the gills are free but not sinuate, nor is the stipe glabrous as described for *A. pantherinoides*.

During the Spring of 1927, two persons at Scio, Oregon, were severely poisoned by eating this fungus. I learned from the attending physician that they were unconscious for about 10 hours, with occasional states of spasms, accompanied by tightly set jaws and widely open eyes. From this, they lapsed into a delirious condition before regaining consciousness. Both patients recovered. Plants collected in the same locality where those causing poisoning were obtained had pilei which shade from tawny-olive in the younger specimens to cinnamon-buff or even pinkish-buff in expanded mature specimens.

53. **Lepiota decorata** Zeller, n. nom.

Syn. *Lepiota pulcherrima* Zeller (Myc. **14**: 186. 1922)—not *Lepiota pulcherrima* Graff. (Phil. Jour. Sci. **9**: **C**: 244. 1914.)

54. ARMILLARIA AMIANTHINA (Fries) Kauffman.[2]

In open woods, Corvallis. November. No. *6862*.

55. TRICHOLOMA RUTILANS Fries.

On Douglas fir wood in damp woodlands, Corvallis. Rather frequent. October to December. No. *2391*.

This wood-inhabiting Tricholoma as it grows in Oregon has the sterile cells at the gill margins as illustrated by Ricken.

56. CLITOCYBE AMARA Fries.

In mixed woods, Corvallis. October to December.

According to Dr. C. H. Kauffman *Tricholoma bicolor* Murrill is referable here. The writer has studied several collections of Oregon material and finds no way to distinguish it from Ricken's description of *C. amara*.

57. CLITOCYBE TABESCENS Bres.

On rotted wood in the soil, Corvallis. December. Nos. *2382*, *6859*.

The Oregon collection is typical. The spores are spheroid-ellipsoid, 6–7 μ, and basidia are $21 \times 11\ \mu$. Edible.

58. COLLYBIA CONIGENOIDES Ellis.

[2] Kauffman, C. H. The genus Armillaria in the United States and its relationships. Papers Mich. Acad. Sci., Arts, Letters **2**: 53–67. 1922.

On cones of *Pseudotsuga taxifolia*, Corvallis. November. Not uncommon. No. *6863*.

The Oregon plant is similar to that occurring in the eastern and middle United States. The spores are minute, smooth, unequal, oblong, 3–4 × 2 μ. The cystidia are numerous on the edges of the gills but also scattered in the hymenium. They are lanceolate and often crowned, 30–55 μ long. The characters of the stipe conform to those mentioned by Kauffman.[3]

59. CANTHERELLUS ALBIDUS Fries (?).

Rocky woods, Hood River County. March. Infrequent. No. *6937*.

Dr. L. F. Henderson took this collection. It conforms quite closely with Ricken's description of this species.

60. CANTHERELLUS CINEREUS (Pers.) Fries.

On ground, Corvallis. March. Infrequent. Collected by C. E. Owens. No. *6930*.

61. CANTHERELLUS TUBAEFORMIS Fries.

Hood River County. Infrequent. October. Collected by L. F. Henderson. No. *63*.

62. LENTINUS LEPIDEUS Fries.

On oak posts, Corvallis. July. No. *2364*.

This fungus was collected on *Pinus ponderosa* at many stations in Central Oregon by Prof. W. E. Lawrence.

63. PHOLIOTA BLATTARIA Fries.

Under *Acer macrophyllum*, Corvallis. December. No. *6858*.

This species previously has been reported as far west as Missouri. The spores are 7–8 × 3–4.5 μ and the clavate to fusiform cystidia on edges of the gills are 30–40 × 8 μ. The tramal tissues are composed of large hyphae with vesiculate cells up to 60 × 22 μ. The annulus is striate above as shown in Ricken.

64. PHOLIOTA MARGINATA Fries.

Hood River County. October. Frequent. No. *6936*. Collected by L. F. Henderson. No. *52*.

65. HEBELOMA FASTIBILE Fries.

In oak woods, Salem. December. No. *6860*.

[3] Kauffman, C. H. Agaricaceae of Michigan. Mich. Geol. and Biol. Survey Pub. 26 (Biol. Ser. 5). 1918. (*See p. 772.*)

The Oregon material conforms very closely with Ricken's description of European collections.

66. BOLBITIUS VITELLINUS Fries.

On manured soil, Corvallis. May. Frequent. No. *6941*.

67. STROPHARIA SQUAMOSA Fries.

In fir woodlands, Corvallis. November. No. *6865*. Very common.

68. HYPHOLOMA CANDOLLEANUM Fries.

In open oak woods, Monmouth. April. No. *6876*.

The spores are 6.8–8 $\times$ 3–4 μ, and the gills are white becoming dull pink and then violaceous as described by Ricken for the European plants.

69. COPRINUS COMATUS Fries.

In rich soil, Corvallis and Newberg. November. No. *2457*.

70. PANAEOLUS PAPILLIONACEUS Fries.

On horse dung, Corvallis. April. Common. No. *6903*.

71. PANAEOLUS RETIRUGIS Fries.

In gardens, Corvallis. April. No. *2456*.

72. PANAEOLUS SUBBALTEATUS Berk.

On enriched soil, Corvallis. May. Infrequent. No. *6940*.

In this collection the spores are 12–14 x 7.5–8.8 μ; basidia 25 $\times$ 8–9 μ, and the scattering cystidia are pointedly ellipsoid with brownish tips, often truncate, 30–32 $\times$ 7–8 μ.

73. GOMPHIDIUS OCHRACEUS Kauffman.

Under conifers, Hood River County. October. Frequent. No. *6934*.

Collected by L. F. Henderson. Nos. *56* and *58*.

74. GOMPHIDIUS SUBROSEUS Kauffman.

Under conifers, Hood River County. October. Frequent. No. *6932*.

Collected by L. F. Henderson. No. *57*.

It gave considerable satisfaction to examine the collections of these two species of *Gomphidius* for in the Willamette Valley the predominating species of this genus is *G. oregonensis* Peck, while *G. tomentosus* Murrill which occurs frequently in the Cascade Range has not been found in this valley.

75. VOLVARIA SPECIOSA Fries.

On horse dung in cultivated gardens, Corvallis. April to June. Frequent. Nos. *7069*, *7080*.

Family 8. LYCOPERDACEAE

76. TYLOSTOMA AUSTRALIANUM Lloyd.

In sandy soil, Ontario. July. Infrequent. No. *1581.*

This species is rarely found in Oregon. The peridium is not colored. The cortex is of the nature of a sand case. The stipe is darker, rather smooth but sometimes with mycelial strands adhering to the lower half. The mouth of the peridium is irregularly torn. The capillitium is hyaline, thick walled, slender with few strongly swollen septa. Spores are subglobose, 4–5 μ, smooth under ordinary power of microscope, granular under strong oculars. The late Mr. C. G. Lloyd has told the writer that this is *T. Berkeleyii* Lloyd but, according to the descriptions, it is nearer to *T. australianum.*

77. TYLOSTOMA POCULATUM White.

In sandy loam, east of Corvallis. Infrequent. October. No. *1923.*

This species has previously been reported from Nebraska, Colorado and Australia. This collection extends the westward range to Oregon.

78. TYLOSTOMA VERRUCOSUM Morgan.

In sandy soil, Linn County, near Corvallis. Infrequent. October. No. *2333.*

79. GEASTER TRIPLEX Jungh.

In coniferous forest, Corvallis. November. No. *2617.*

Family 9. HYMENOGASTRACEAE

80. RHIZOPOGON RUBESCENS Tul. var. VITTADINII Tul.

Under conifers, Corvallis and Hood River. September to January. Nos. *2550, 2562, 7020.*

This, I believe, is the most common *Rhizopogon* to be found in western Oregon. My largest collection, taken on the college campus in December, consisted of 197 fructifications, having a total weight of 3 lbs. 12 ozs.

81. RHIZOPOGON OCCIDENTALIS Zeller & Dodge.

In sandy soils, Newport and Hood River. Frequent. October to December. Nos. *2438, 2551* and *6933.*

All of these collections were taken by Dr. L. F. Henderson, who collected the type specimen many years ago at Moscow, Idaho.

82. GAUTIERIA GRAVEOLENS Vitt.

Under maples, Corvallis. Infrequent. September. No. *2568*. This is the first report of this species west of Ithaca, N. Y.

Family 10. NIDULARIACEAE

83. CYATHUS STRIATUS (Huds.) Pers.

On fir wood, Corvallis. March. Infrequent. No. *2637*.

FUNGI IMPERFECTI

Family 11. PHOMATACEAE

84. PHYLLOSTICTA MAHONIAECOLA Pass.

On *Mahonia nervosa*, near Corvallis. February. No. *2492*.

85. PHOMA GLANDICOLA (Desm.) Lév.

On acorns of *Quercus garpyana*, Corvallis. February. Common. No. *6873*.

86. PHOMA PHILADELPHI Cooke.

On stems of *Philadelphus gordonianus*, Corvallis. May. No. *6834*.

87. CICINNOBOLUS UNCINULAE Fautr.

Parasitic on *Sphaerotheca Humuli* on salmon berry (*Rubus spectabilis*), Astoria. August.

The open urn-shaped perithecia are membranaceous, $40 \times 88\ \mu$, or smaller, and the spores are elongate-ellipsoid, $6–8.8 \times 2.5–3.5\ \mu$.

88. FUSICOCCUM PYRORUM Chupp & Clapp.

On die-back apple twigs, Junction City. February. No. *1667*.

89. CYTOSPORA CHRYSOSPERMA (Pers.) Fries.

On poplar, Ontario. July. No. *2537*.

This organism is doing a great deal of damage to poplars in the Boise and Payette Valleys in Idaho and in the Snake and Malheur Valleys in Oregon.

90. CONIOTHYRIUM FUCKELII Sacc.

On Cuthbert red raspberry, Himalaya black berry and Cumberland black raspberry, Corvallis and Newberg. April and August. Very infrequent. Nos. *2653*, *6783*, *6914*.

91. CONIOTHYRIUM HELLEBORI Cooke & Massee.

On *Helleborus niger*, Salem. September. Collected by Mrs. Mary Clemens. No. *2479*.

92. DIPLODIA MAURA Cooke & Ellis.

On winter injured pear bark, Corvallis. January. Infrequent. No. *7186*.

93. SEPTORIA ACERIS-MACROPHYLLI Peck.

On *Acer macrophyllum*, Corvallis. October. No. *2616*.

94. SEPTORIA ALNI Sacc.

On leaves of *Alnus Oregona*, Corvallis. July. No. *2452*.

95. SEPTORIA ALNIFOLIA Ellis & Ev.

On *Alnus Oregona*, Corvallis. June. No. *2514*.

96. SEPTORIA CORYLUS Peck.

On *Corylus Californica*, Corvallis. August. No. *2608*.

97. SEPTORIA NARVISIANA Sacc.

On *Scirpus occidentalis*, Triangle Lake, Lane County. August. No. *6773*.

98. SEPTORIA POPULI Desmz.

On *Populus trichocarpa*, Kiger Island, Benton County. June. No. *2454*.

99. SEPTORIA SALICINA Peck.

On *Salix* sp., Corvallis. September. No. *2614*.

100. SEPTORIA SAMBUCINA Peck.

On *Sambucus glauca*, Corvallis. October. No. *6884*.

101. SEPTORIA STELLARIAE Rob. & Desm.

On *Stellaria media*, Alsea Mt., Benton County. Infrequent. No. *6810*.

This collection made by H. P. Barss is typical, having spores 50–80 × 1 μ.

102. RHABDOSPORA RUBI Ellis.

On canes and fruiting laterals of the wild black raspberry (*Rubus leucodermis* Doug.), Benton County. Infrequent. O. A. C. Herb. No. *4850*.

This fungus was collected by H. S. Jackson, July, 1914. His photograph of it is illustrated in text figure 2.

The spots are purplish to brownish red and become pallid white dotted with the black pycnidia. Pycnidia are 120–160 μ in diameter; spores bacilliform, 25–40 × 1–1.5 μ, hyaline. This is the first report of this parasitic fungus west of Illinois. (FIG. 2.)

FIG. 2. Cane lesions produced by *Rhabdospora Rubi* Ellis on fruiting laterals of *Rubus leucodermis* Doug. Photo by H. S. Jackson.

Family 12. MELANCONIACEAE

103. GLOEOSPORIUM OBTEGENS Sydow.
On *Pteridium aquilinum*, Marion County. August. No. *2506*.
104. MARSSONIA PIRIFORMIS (Riess.) Sacc.
On *Populus alba*, Cottage Grove. September. No. *2611*.
105. SEPTOGLOEUM NUTTALIAE Harkn.
On *Osmaronia cerasiformis*, Corvallis. No. *2610*.
106. CORYNEUM RHODENDRI Schw.
On leaves of *Rhodendron*, Newport. April. No. *6909*.
Spores of this species are 5-septate, constricted at the septa, 17–22 × 6–8 μ, terminal cells hyaline, usually appendiculate.
107. PESTALOZZIA HARTIGII Tubeuf.
On pear seedlings suffering from heat canker, Dillard. August. Infrequent. No. *7091*.
108. PESTALOZZIA TRUNCATA Lev. var. *Rubi* Karst.
On dead canes of *Rubus*, Alpine. April. No. *6812*.
Acervuli gregarious, showing black, elliptical, on a gray background, erumpent; conidia oblong, 3-septate, not constricted, 2 middle cells fuliginous, end cells hyaline, terminal 2–3-ciliate, basal long filiform pedicellate, 13–15 × 6 μ.

109. CYLINDROSPORIUM CRATAEGI Ellis & Ev.

On *Crataegus*, Linn County. June. No. *2455*.

110. LIBERTELLA CORTICOLA A. L. Smith.

This was found growing saprophytically as a die-back fungus, following winter injury. The spores are slightly curved, 25 × 1.5–2 μ.

Family 13. MONILIACEAE

111. OOSPORA HYPOXYLICOLA (Preuss.) Sacc.

On *Plowrightia morbosa*, Corvallis. April. Infrequent. Nos. *2291*, *2297*.

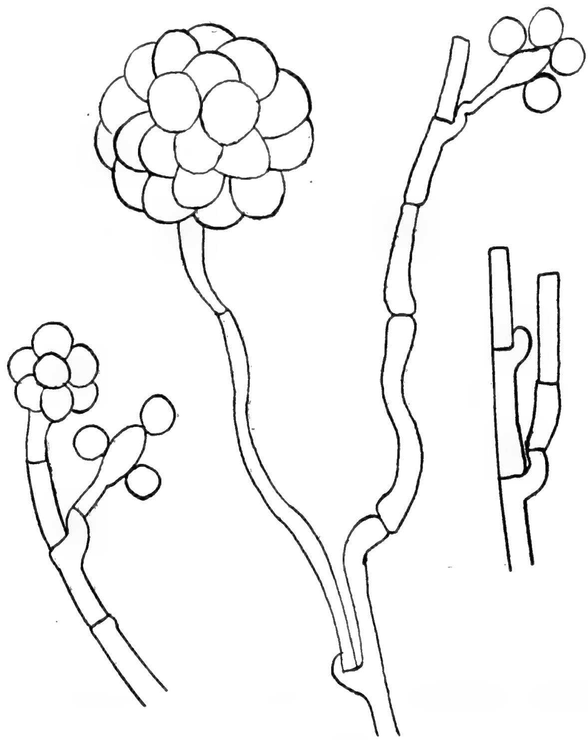

FIG. 3. Mycelium and conidiophores of *Phymatotrichum fungicola* Zeller.

112. **Phymatotrichum fungicola** n. sp.

Hyphae 2.5–4 μ in diameter, hyaline, septate, often with clamp connections and medallions. *Fertile hyphae* arising irregularly, simple or branched, forming with the conidia creamy, pulverulent

masses; *conidia* from swollen heads of the fertile hyphae, subglobose, 6–10 μ in diameter. (FIG. 3.)

Forming pulverulent masses of a creamy white color on the acervuli of *Myxosporium corticola* and *Neofabraea malicorticis*, Corvallis. January to March. Frequently found. No. *6871*.

113. BOTRYTIS POEONIAE Ond.

On dead peony stalks, Corvallis. February. Infrequent. No. *6877*.

The flattened sclerotia adhere to the stalks under the epidermis.

114. OVULARIA OBLIQUA (Cooke) Ond.

On *Rumex*, Corvallis. November. Nos. *2530*, *2555*.

115. CLONOSTACHYS ARAUCARIA Preuss.

Isolated from dead pear bark, Roseburg. August. No. *7035*.

Family 14. DEMATIACEAE

116. CLADOSPORIUM HERBARUM (Pers.) Link.

On black raspberry canes, Independence. March. Frequent. No. *2495*.

Family 15. STILBACEAE

117. STYSANUS STEMONITES (Pers.) Corda.

Isolated from potato tubers by M. B. McKay, Corvallis. February. Infrequent. No. *2629*.

Family 16. TUBERCULARIACEAE

118. FUSARIUM MERISMOIDES Corda.

On stems of *Zea maydis*, Corvallis. Frequent. March. No. *6889*.

This is a very common fungus causing decay of corn stalks in field and silage.

119. FUSARIUM VITICOLA Thüm.

On cultivated currant stems, Corvallis. Infrequent. No. *2476*.

The pink sporodochia were found breaking through the epidermis on dead areas of the stems. The material of the two species of Fusarium was identified by Dr. H. W. Wollenweber.

OREGON AGRICULTURAL COLLEGE,
CORVALLIS, OREGON

NOTES AND BRIEF ARTICLES

The meetings of the mycologists in connection with the American Association for the Advancement of Science held in New York City during the winter were very well attended and the papers presented were unusually interesting. The sessions were presided over by Dr. L. O. Overholts of Pennsylvania State College.

Dr. J. C. Arthur wishes to announce that the book on "The Plant Rusts" by himself in collaboration with F. D. Kern, C. R. Orton, F. D. Fromme, H. S. Jackson, E. B. Mains and G. R. Bisby, will be issued early in the year and will be published by John Wiley & Sons, Inc. It is expected that the book will embrace approximately 500 pages with many illustrations. The book will be welcomed by all mycologists.

Professor T. H. Macbride, Associate Editor of MYCOLOGIA and well-known authority on slime-moulds, has digressed from the beaten path long enough to write "In Cabins and Sod-Houses." This work is not at all mycological but is a vivid picture of early Iowa life as known by him and as often recounted to some of us by our parents. The work is published by the State Historical Society of Iowa, is written in the usual scholarly manner and is very readable.

Mr. H. K. Lewcock, who has been spending several years in America trying to discover some bacterial or fungus parasite which can be introduced into Australia to kill off the cactuses, sailed for Australia on January 31. He will spend some time in an attempt to make a practical application of some of the promising discoveries made in this country.

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL GARDEN

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No. 17. The Tylostomaceae of North America, by V. S. White.

No. 24. The Nidulariaceae of North America, by V. S. White.

No. 27. Some Mt. Desert Fungi, by V. S. White.

Nos. 29, 32, 35, 38, 41, 49, 52, 56, 60, 65, 69, 70 and 74. The Polyporaceae of North America, I–XIII, by W. A. Murrill.

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EDITOR

FRED JAY SEAVER

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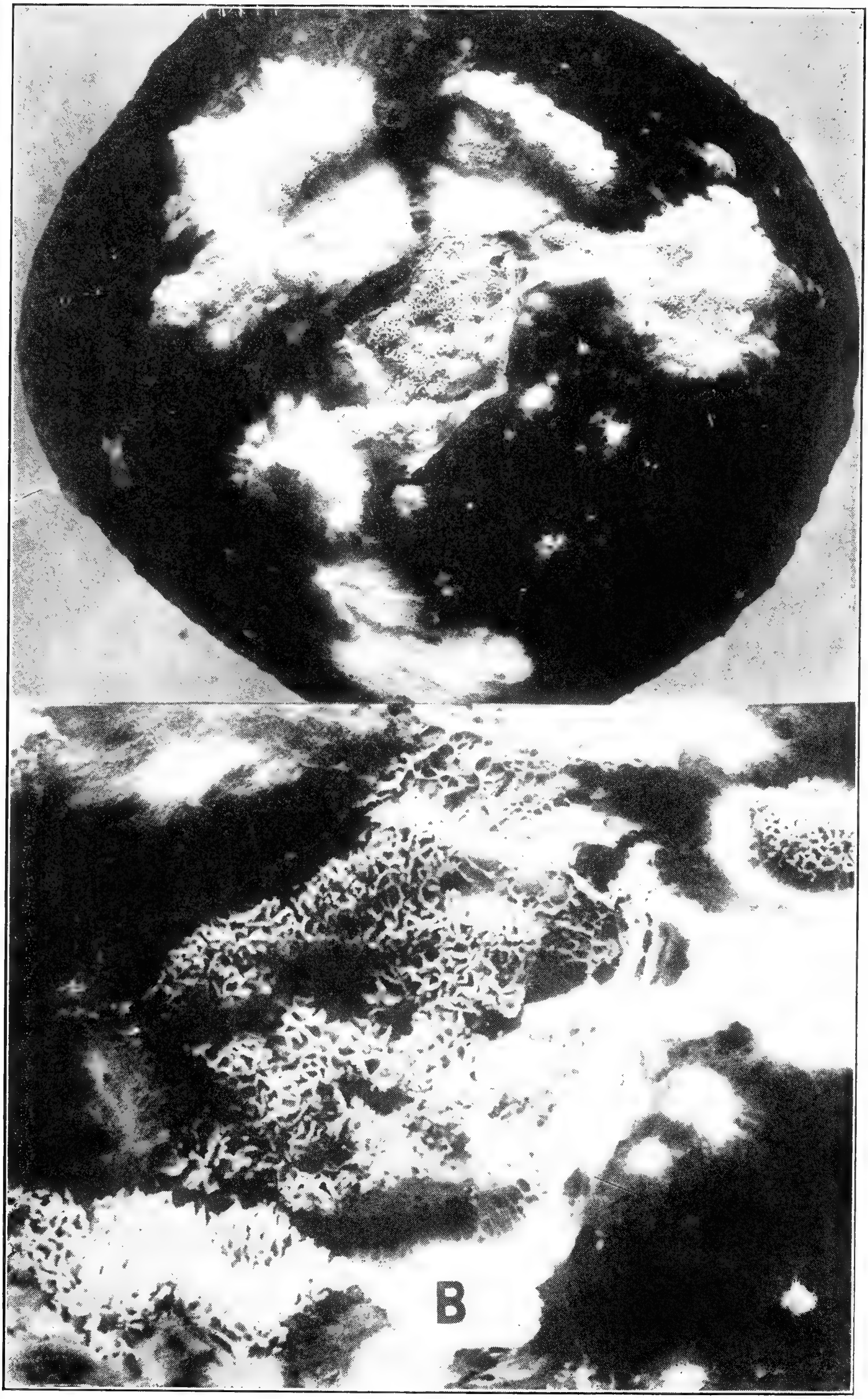

PORIA COCOS

MYCOLOGIA

VOL. XXI MAY–JUNE, 1929 NO. 3

THE OCCURRENCE OF TUCKAHOES AND PORIA COCOS IN FLORIDA

GEORGE F. WEBER [1]

(WITH PLATE 11 AND 5 TEXT FIGURES)

INTRODUCTION

During the past several years, numerous growers and farmers in Florida have sent to the Experiment Station various tuckahoes for examination and information. They have been found in widely distributed portions of the state, which would lead one to believe that they are quite at home in the more sandy types of Florida soils. The literature concerning the description and distribution of tuckahoes is somewhat scattered and not easily available.

The description which follows deals wholly with a solid sclerotium of irregular size and shape, which is of various brownish shades, white and granular within, and covered by a crusty, fibrous or scaly, bark-like coat.

Early in 1923, spore-producing structures, developed by artificial means, were observed upon a number of these sclerotia. This paper is designed to make available information concerning the history, description and distribution of the tuckahoe, so far as known at this time.

HISTORICAL

The earliest writings concerning tuckahoes appeared in a history of the state of Virginia (**4**), in which there are paragraphs relating to the tuckahoes which the Indians dug out of the ground. Under this term were included a large number of

[1] Published with permission of the Director, Florida Agricultural Experiment Station. Photos by Kelbert.

[MYCOLOGIA for March–April (**21**: 55–112) was issued March 1, 1929]

terrestrial plant parts, mostly bulbs and roots, referred to as "earth-nuts," "wild onions," "tuberous roots," etc. Certain of these roots were specifically designated as "tuckagoe" and when eaten raw were quite pungent. However, in case of necessity, the Indians managed to make a bread from these tuberous growths. These particular plants grew like the flags in the wet

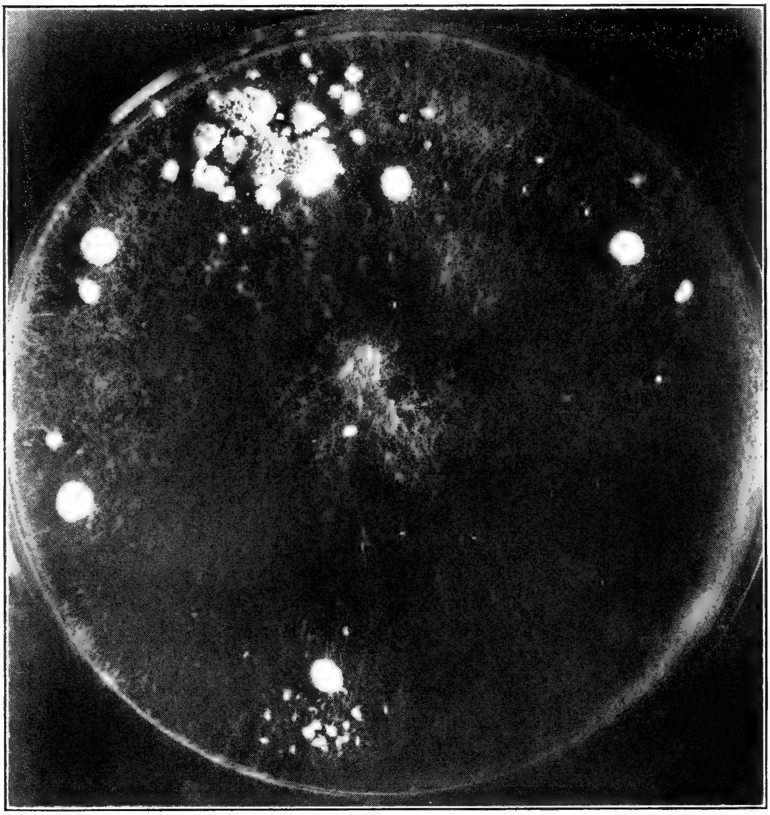

FIG. 1. Fungus in pure culture, planting obtained aseptically from interior of disinfected sclerotium. Fruiting structures developed on potato-dextrose agar in ten days.

marshes and the roots resembled Irish potatoes in size and flavor. Clayton (**8**) classified certain types of tuckahoes that were apparently of a fungous origin, as *Lycoperdon solidum*, and stated that they were very large tubers of the ground, the outside of which was rough, that they were white within and that the Indians used

them for making bread. Kalm (**23**) writes that "tawko" or "tawking" was the Indian name for the plant which produced the edible roots. In some places, these roots were known as "tuck-ah" and grew in moist ground or swamps. These descriptive terms probably referred to the common wake-robin, *Arum virginicum*. Another plant commonly found growing in swampy places, namely the golden club, *Arontium aquaticum*, was referred to by the natives by the terms "tawkee," "tawkin," "tockim" and "tockin." These were undoubtedly included under the term "tuckahoe" as found in North Carolina by Beverly (**4**). These roots grew as large as eight inches in diameter and were cooked in fire-pits. They were somewhat pungent and probably slightly poisonous when fresh. Macbride (**26**) thought that tuckahoes were the roots of *Erythrina verbacea* or *Convolvulus panduratus*. Smith (**39**) wrote that the chief root used by the natives was called "tockôuhoughe" and that it grew like flags in marshy places and was so plentiful that "a native could gather enough in a day to provide food for a week." These roots resembled potatoes in size and flavor. They were prepared for eating by covering them with wood and firing for twenty-four hours. They were then sliced and dried in the sun and later ground up and mixed with sorrel and meal and used as bread. They were quite bitter when raw and, even when cooked, produced a prickling in the throat when eaten. This astringentness according to Elliott (**14**) was typical of the tuberous roots of *Convolvulus panduratus* and it may be concluded that this was the plant described above. Torrey (**42**) made probably the first analysis of the tuckahoe and found that it contained a substance known as "glutin," but was largely composed of a vegetative principle which he designated by the term "sclerotin." It was probably this analysis that prompted Macbride (**26**) to give it the generic name of "Sclerotium." According to Gore (**20**), Nuttall listed the tuckahoe by the name of *Lycoperdon sclerotium* and Schweinitz (**37**) listed it as *Sclerotium Cocos*. Torrey (**42**) stated that "sclerotin" was identical with "pectous substances" as found by the analysis of Braconnet (**5**), who analyzed tuckahoes and described the jelly-like substance as "pectose." Johnson (**22**) related that the tuckahoe was often referred to by the

early settlers as Indian bread and states that the tubers produced no roots or foliage. He also concluded that the roots of certain species of *Convolvulus* were erroneously included under the term tuckahoe. Berkeley (**3**) described the tuckahoe as a large, tuberous growth found in the southern part of the United States. Also that the fructifications, which he suspected were fungoid in nature, had not been seen. Unger (**43**) wrote that the tuckahoe was found in the southern states of North America and referred to it as the Indian potato or Indian bread. He mentioned the gigantic *Lycoperdon solidum*, which attained a weight of fifteen to thirty pounds. He also mentioned that it sometimes furnished the entire food for run-away slaves. Gore (**20**) included tobacco root, *Valeriana edulis*, under the term tuckahoe as used by early writers. Campbell (**7**) stated that the tuckahoe root was a spontaneous production in the soil. He also pointed out the difference between this tuckahoe and the roots of the plant, *Convolvulus panduratus*. Brown (**6**), after an analysis of *Sclerotium giganteum*, concluded that it was not of high value as a food. Dodge (**12**) listed a score of plants, the roots of which have been referred to in one way or another as tuckahoes or Indian bread. He gives in an encyclopedia of chemistry, under the article on "picquotaine," the description of a highly nutritious plant part which was used as food by the Indians and was the result of a disease of the plant *Psoralea esculenta*. Storer (**41**) stated that the tuckahoe, or Indian bread, was subterranean in its habitat and was sought and eaten by hogs, Indians and natives. Lockwood (**25**) wrote that the tuckahoe looked somewhat like a baked sweet potato and that the contents were flour-like when dried and ground; otherwise the interior was essentially starchy. Ravenel (**34**) said that the tuckahoes were usually picked up on plowed ground and were always found when they were full grown and that he had not seen them either in growing condition or partially developed. Banning (**2**) wrote that the tuckahoes were soft when fresh and coconut-like in appearance, varying in size and shape and that, after two seasons of careful observations, no fruiting forms of the fungus had been found. Fisher (**16**) presented considerable morphological and chemical analyses and concluded that the sclerotium of *Pachyma Cocos* was

of fungous origin, despite the fact that woody tissue was often present in the younger and smaller sclerotia. Other writers have more or less reviewed the early literature and have connected

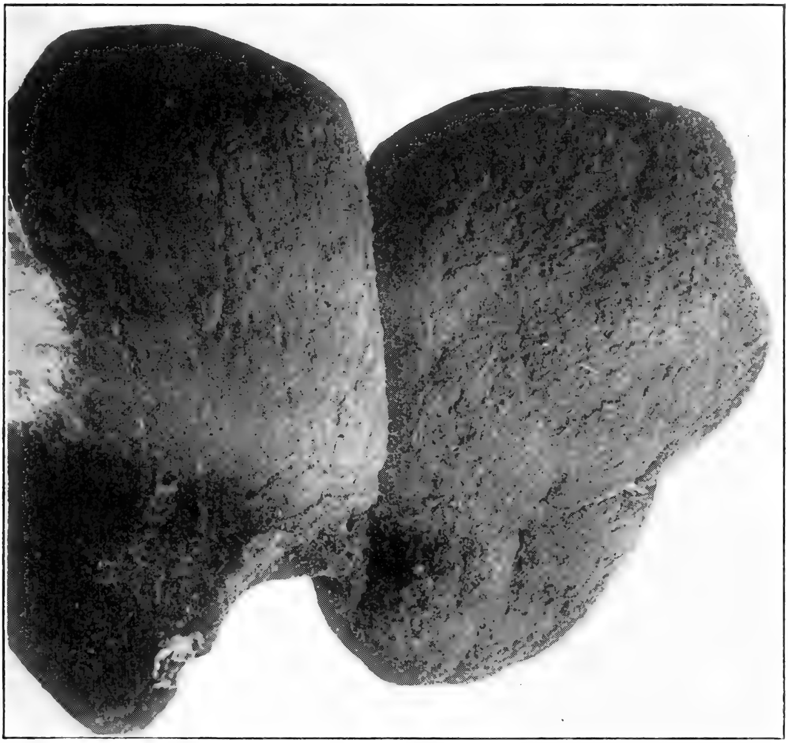

FIG. 2. Sclerotium of *Poria Cocos* (Schw.) Wolf from citrus root.

the tuckahoe, a term used in earlier literature referring to the tuberous roots of higher plants, to the fungus *Pachyma Cocos* as described by Fries (**17**). The recent developments will be taken up in this paper under separate headings.

GEOGRAPHIC DISTRIBUTION

Fries (**17**), Banning (**2**), Gore (**20**), Unger (**43**), Johnson (**22**) and Storer (**41**) report the occurrence of the tuckahoe in pine forests in Delaware, New Jersey, New York, Pennsylvania, Virginia, Maryland, Carolinas, Tennessee, Georgia, Mississippi, Arkansas, Kansas, Texas and Florida. Wolf (**46** and **47**) ob-

tained 19 specimens from the vicinity of Raleigh, N. C., and later reported 11 additional specimens from the same state. There have been some reports of specimens of this nature other than those found in the United States, namely by Güssow (**21**) from Canada, by Engler and Prantl (**15**) from eastern Asia and by Gore (**20**) from Tasmania and eastern Australia.

The locations where tuckahoes have been found in Florida are as follows: Gainesville, Lake City, Citra, Lake Alfred, Sebring, and Redlands. The largest number found were collected at Citra in 1923.

HABITAT

In Florida most of the tuckahoes have been found in the sandy soils. In their distribution in the soil they range from being only slightly covered with sand to several feet deep. Gore (**20**) stated that light sandy soil or sandy loam not too wet was the best environment for these sclerotia and that none, as far as he knew, were found in old fields or wood lands. Ravenel (**34**) stated that they were picked up on plowed ground, while Güssow (**21**) found them in poplar woods. Lockwood (**25**) found them 18 inches deep in yellow, ferruginous sand and, in this specific instance, encircling a 5/8 inch oak tree root. Wolf (**46**) believed that they are generally distributed over sandy soils of North Carolina through flat-woods, hammock and grove lands, being parasitic and attached to tree roots (usually showing places of attachment) buried in the sand in various depths up to two feet.

ECONOMIC IMPORTANCE

From accounts of Banning (**2**) and Unger (**43**), it appears that these sclerotia were at times used for food, being roasted and eaten by southern negroes, who had learned of their use from the Indians. Clayton (**8**) and MacBride (**26**) stated that they were used in making some sort of bread. Smith (**39**) wrote that the sclerotia were always roasted, they being usually about the size and shape of potatoes, but were never eaten raw, because they were considered poisonous. Fries (**17**) stated that they contained certain medicinal properties and were used in this respect by the natives. Rafinesque (**33**) wrote that tuckahoes were most delicate of all foods, inodorous and of fine taste. Murrill (**28**)

did not think that they were used much as a source of food and there was no foundation for mere curative virtues from a medicinal standpoint.

HOST RANGE

These sclerotia have been reported as associated with the roots of native trees more than any other type of vegetation. Elliott

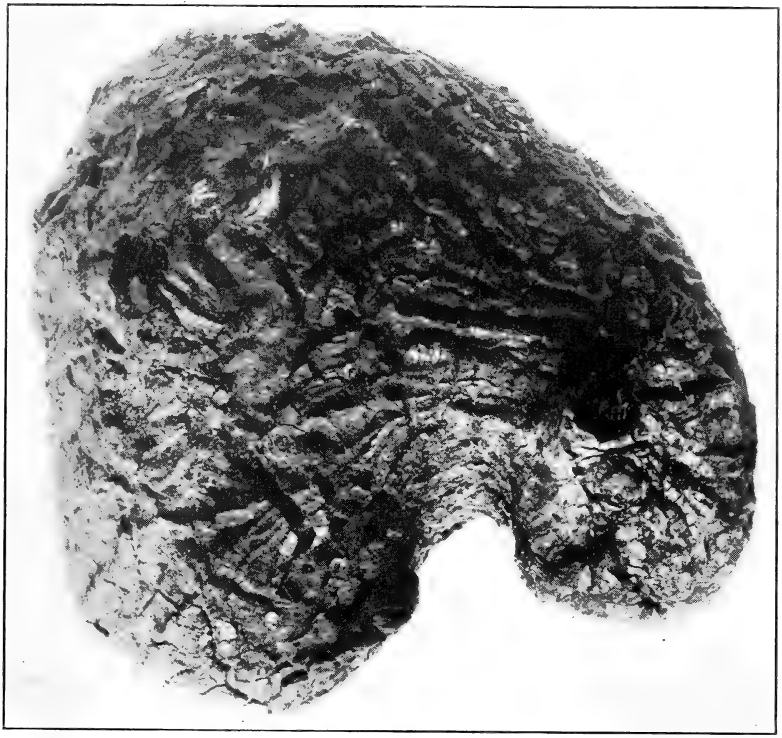

FIG. 3. Sclerotium of *Poria Cocos* (Schw.) Wolf from *Magnolia* sp.

(**13**) recorded them on sumac roots, Fries (**17**) and Schweinitz (**38**) on pines and Lockwood (**25**) on the roots of the willow oak, *Quercus phellos*. Maiden (**27**) and Murrill (**28**) reported them on eucalyptus roots. Prillieux (**32**) had always found them associated with pine roots. Wolf (**46, 47**) found them parasitic on the roots of pine and oak trees and on corn. Stille and Meisch (**40**) found them on the roots of fir trees and Coker (**9**) reported them on the roots of cedar. The writer (**45**) reported them at-

tached to the roots of citrus trees. To date sclerotia have been found in Florida on the roots of magnolia, *Magnolia grandiflora*, grapefruit, *Citrus paradisi*, oak, *Quercus sp.*, sweet orange, *Citrus sinensis*, and eucalyptus, *Eucalyptus sp.*

DESCRIPTION

Most of the recent descriptions of the tuckahoe are quite similar and the writers have undoubtedly been talking about a definite type of fungous sclerotia rather than tuberous root growth of higher plants. Gore (**20**) describes them as being moist and pliable when fresh, tasteless and drying exceedingly hard. The entire sclerotium, except possibly some of the fibers of the outer coat, which resembles the bark of roots, is fungoid in nature. The sclerotia are brown to blackish on the outside and white or pinkish within. Gore's interpretation is that the fungus invades the parenchyma tissue, replaces it, and utilizes the host bark as a natural covering until it is outgrown by the increasing sclerotium, when it is replaced by a wall laid down by the fungus itself. The interior portion is white, granular and spongy and possesses a pronounced fungous odor. Engler and Prantl (**15**), Schrenck (**35**), Maiden (**27**) and Prillieux (**32**) agree that the white, pliable interior was somewhat granular. Stille and Meisch (**40**) note an insipid taste to the inner contents, but do not note any odor accompanying the same.

Banning (**2**) and Lockwood (**25**) stated that the tuckahoe resembled very much in shape the common cultivated sweet potato. Fries (**17**) compared the sclerotia to coconuts in their size and shape and external appearance, but stated that they were larger and harder and often varied in shape from spherical to elongate. The sclerotia found in Florida have been of various sizes and shapes. The majority, however, were oblong to subglobose and none of them were elongated as those found and described by Wolf (**46**). None of the Florida specimens have been more than twice as long as wide. Some of them, however, have been slightly flattened, while others were pointed at one or both ends. The largest found in the state measured 38 inches in circumference the long way round and 25 inches in circumference around the meridian. This specimen weighed 14½ pounds when

fresh and 11 pounds after drying several weeks in the laboratory. The smaller ones were about the size of hen's eggs and more or less irregular in outline. The type described by Wolf (**46**) was longer than these specimens, one measuring 41 inches long and another one, that was more or less subglobose, measured 27 inches by 19 inches. The largest specimen found by Coker (**9**) weighed 22¾ pounds. The specimens described by O'Connor (**31**) weighed 8½ and 5½ pounds and were 8½ inches by 7 inches and 8 inches by 6¾ inches respectively. Maiden (**27**) described sclerotia that weighed 14, 25 and 39 pounds. Johnson (**22**) described the size of the sclerotia seen by him as varying from the size of acorns to the size of a man's head. The largest sclerotia seen by Güssow (**21**) was 22 by 33 inches in circumference. Prillieux (**32**) and Gore (**20**) described the cortex as rough, crevassed, scaly, often with fibrous appearance, wrinkled, resembling bark of a tree, somewhat warty, of a brownish-black color, tough and flexible when fresh and drying hard and scale-like. The Florida specimens are very well described by the above, with the possible exception of the small ones, which resemble more closely the bark of trees, the cortex being more or less striated and ridged from end to end. The cortex averages from 3–8 mm. in thickness and is often wrinkled and crevassed, furrowed or grooved, and sometimes quite coarse in texture, especially in the largest specimens, whereas the small ones are often somewhat smooth and more or less warty. The fresh specimens were easily dented by pressure in the hands and, after removal of the pressure, the specimen resumed its previous shape. The outer coat became very coriaceous and hard after the specimens had dried thoroughly. The cortex did not separate readily from the inner portion.

Very little is known about the dissemination of the fungus, but it can readily be supposed that the fungus is spread by the transmission of spores by insects, running water, etc., and that these spores may germinate and infect the roots of plants, thereby growing and reproducing the sclerotia. On the outer coat of a number of sclerotia collected in Florida were found the remains of numerous clusters of weathered and somewhat disintegrated sporophores resembling fruiting structures of a *Poria* (see FIG. 5).

Sporophores produced artificially in pure culture were very similar to the old fruiting structures on the sclerotium. They are probably the same and thus may develop in nature, although fresh fruiting structures have not been observed under natural

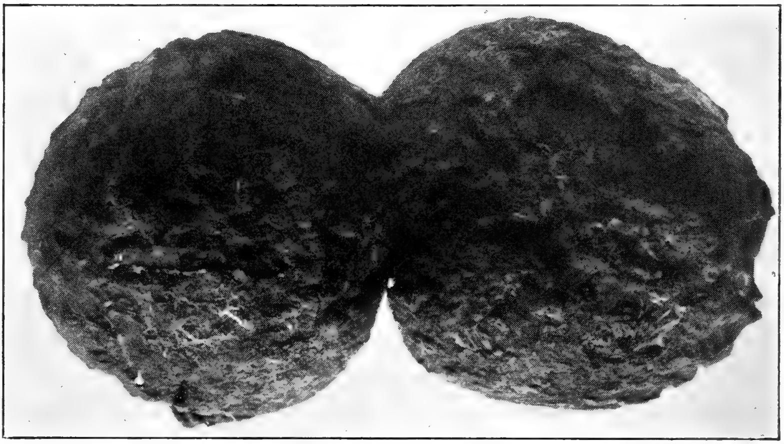

FIG. 4. Sclerotium of *Poria Cocos* (Schw.) Wolf from *Eucalyptus* sp.

conditions. The fruiting structures associated with the sclerotia have been observed by a number of writers and, in most cases, have been considered to be of a saprophytic nature. Schrenck (**35**) was of this opinion and considered the sclerotium as an aggregation of an exudite of plants in the form of an accumulation of gum and gave it the name of gummosis or pectosis. Elliott (**13**), in making a microscopic examination of the fungus, observed the presence of clamp connections. Wolf (**46**, **47**) considered the sclerotia as a compact mass of fungous tissue in which he found rhizomorphs. In the sclerotia he found in corn stalks, the fungus had invaded the pith of the stalk, replacing the host tissue. The fungus obtained by the writer from plantings of the white inner portion of these sclerotia on poured potato agar plates produced a white, fluffy mycelium in pure culture that grew rapidly over the surface of the medium and there produced the fruiting structures.

COMMON NAMES

The term "tuckahoe" is used at the present time, and has been for a number of years, as the name of a certain type of

fungous sclerotium. Most of the early writers used this name in describing tuberous roots of various kinds. The various tribes of Indians used quite similar terms or words in referring to the tuberous roots collectively. Such words as "tuckahoe," "tawkee," "ptucaui," "petukqui" and "pittikmow" were in common use according to Gore (**20**). Other Indian words as listed by Kahn (**23**) are "tawko," "tawking," "tuckah," "tawkee," "tawkin," "tockim" and "tockin" and referred to more or less bulbous, edible roots. The Chinese term "fuh-ling" is recorded by Stille and Meisch (**40**) as pertaining to edible roots.

The names tuckahoe and Indian bread most frequently appear throughout the early literature and at that time usually referred to all edible roots and almost became generic in their use. They were undoubtedly derived from the group of Indian words for cake or loaf and signified that which is made round and does not refer to the term bread. Consequently, the usual reference for tuckahoe is to all edible tuberous roots, regardless of whether they are phanerogamic or cryptogamic in origin. However, a separation of the cryptogamic plants is necessary in this paper for clarity. The latter will, therefore, be referred to hereafter by the common term sclerotium, the binomial *Pachyma Cocos* (Schw.) Fries, by which the fungus was known for almost a hundred years, or *Poria Cocos* (Schw.) Wolf, by which the fungus is correctly known at the present time.

SCIENTIFIC NAMES

Clayton (**8**) was apparently the first to give a description of the sclerotium and classified it under the name *Lycoperdon solidum*. A few years later, Walter (**44**) gave it the specific name of *cervinum*. MacBride (**26**) gave it another name, *Sclerotium giganteum*, followed by Nuttall (Gore **20**), who reduced the generic name of *Sclerotium* given by MacBride to specific rank. Thus the fungus became known as *Lycoperdon sclerotium*. Later, Schweinitz (**37**) listed it with the specific name *Cocos*. Later he, Nuttall (**30**), thought that it was probably similar to *Sclerotium Cocos* of Schwartz and Schweinitz. Fries (**17**), in giving a new description of this fungus, stated that it was very different from the genus *Lycoperdon* and placed it in a new genus, *Pachyma*, the word being

derived from the Greek, meaning thick and referring to the thick cortex. He adopted Schweinitz' specific name of *Cocos*, referring to coconuts. The descriptions of this genus and species are in detail and adequately cover the fungus as it is known at the present time. Other names appearing in the literature, according to Gore (**20**) and Fries (**19**), are *Pachyma solidum* Oken, *Pachyma pinetorum* Horan, *Pachyma coniferarum* Horan, *Lentinus Tuber regium* Fries and *Agaricus Tuber regium* Fries. Other specimens originating in China are probably synonyms referring to the fungus described herein or a very closely related species. The name *Tuckhaus rugosus* Rafine, which appears in the literature, is probably also a synonym. These above-mentioned names have undoubtedly been applied to the specific fungus under discussion, but the name given by Fries has been carried through the literature in reference to this fungus up until the last few years, when fruiting structures were seen by Wolf (**46**), who placed it in another genus. He was the first investigator to definitely observe the fruiting stage. Because of its manner of producing spores, he placed it in the genus *Poria*, with the specific name of *Cocos*. Thus, after more than one hundred and fifty years of observation and investigation, this baffling problem was solved.

Other names have appeared in the literature that have referred to organisms that are quite different from the fungus mentioned above. Güssow (**21**) obtained a number of specimens and was successful after a ten-month period in producing several fruiting structures that were stipitate rather than resupinate and thus quite distinct. He states that they were entirely different from Gore's specimens and described them as a new species by the name of *Grifola Tuckahoe* Güss. The sclerotium of this fungus was dark and there was imbedded in it numerous small stones and considerable sand. It is, therefore, quite different from the somewhat similar form of *Poria Cocos* (Schw.) Wolf. Elliott (**13**) unsuccessfully attempted to develop the fruiting stage of *Pachyma Cocos*, both on the sclerotia and in culture. Engler and Prantl (**15**) list a sclerotium from eastern Asia by the name of *Pachyma Hoelen* Rumph., but it is evidently a distinct species. Schroeter (**36**) concluded that *Mylitta australis*, as listed by Cooke (**10**), was a sclerotium for which no fruiting stage has been observed, and

was different from *Pachyma Cocos*. Cooke (**11**) described the fruiting structure of this sclerotium a year later as *Polyporus Mylittae* C. & M. Lloyd (**24**) stated that *Polyporus Mylittae* Cooke & Massee—a nature bread of Australia—and *Polyporus tuberaster* Jacq. were both developed from sclerotia which were similar to the tuckahoes of the southern United States. Careful examination of these sclerotia and fruiting structures and their descriptions was made by Güssow (**21**) in reference to his species, *Grifola tuckahoe*, and he concluded that they were different, but that they more closely resembled his species than those referred to by Gore (**20**), namely *Pachyma Cocos* (Schw.) Fries.

Notes in the literature made by a number of different investigators during the time since the tuckahoe was first described have shown that they have been on the lookout for the fructification and in every case they—Berkeley (**3**), Banning (**2**), an anonymous writer (**1**), Engler and Prantl (**15**) and Schrenck (**35**)—have stated that it had not been found.

Since Wolf's paper appeared, another by Murrill (**28**) states that a single sclerotium developed a *Poria*. Weber (**45**) reported development of a *Poria* on a number of specimens. Coker (**9**) was later successful in developing the perfect stage on several sclerotia. Thus, with the verification of Wolf's work, there remains no doubt that the fruiting stage of this sclerotium is a *Poria* and that it has been correctly named as *Poria Cocos* (Schw.) Wolf, with the following synonyms:

Lycoperdon solidum Clayton, Fl. Virg. 176. 1762.
Lycoperdon cervinum Walt. Fl. Carol. 262. 1788.
Sclerotium giganteum Macbride, Trans. N. Y. Philos. Soc. 1817.
Sclerotium Cocos Schw. Syn. Fung. Carol. Super. 30–31. 1822.
Pachyma Cocos (Schw.) Fries, Syst. Myc. **2**: 242–243. 1823.
Pachyma solidum Oken, Lehrbuch d. Naturg. 2 der Tiel Botanik. 1925.
Lentinus Tuber regium Fries, Epic. Syst. Myc. 392. 1836.
Pachyma pinetorum Horaninow 2–23. 1856.
Pachyma coniferarum Horaninow. 1856.
Tuckhaus rugosus Rafine, Med. Fl. N. Am. **2**: 255. 1830.

Development of the Perfect Stage in Florida

During June, 1923, at Citra, Florida, the writer found seven sclerotia (or tuckahoes) attached to the roots of an orange tree. They were regular in shape and weighed from 5 to 9 pounds apiece. The external portion, or cortex, was light brown and

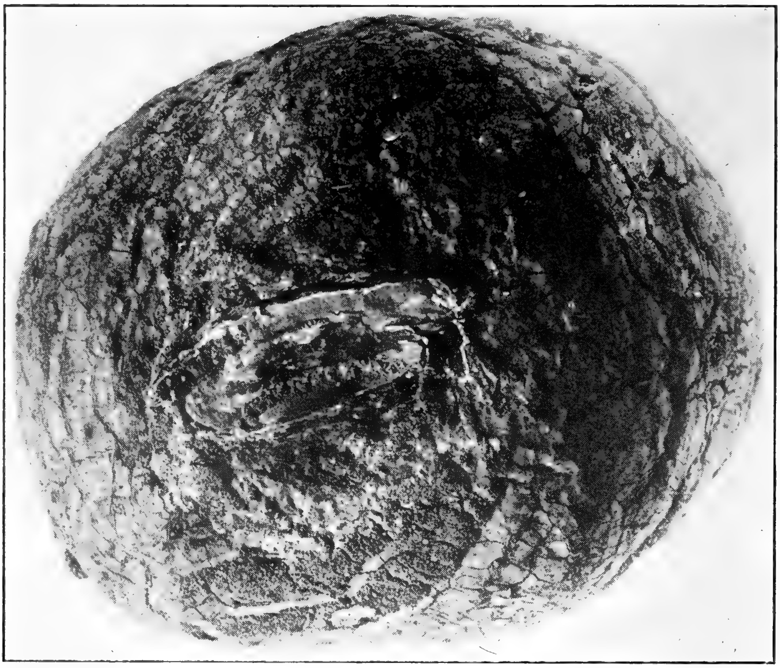

FIG. 5. Sclerotium of *Poria Cocos* (Schw.) Wolf found attached to roots of pine tree, showing place of attachment and series of disintegrated fruiting structures in upper center.

tough, ranging from 3 to 8 mm. in thickness. The interior was white, granular and spongy, having a mushroom (fungous)-like odor. Five of these sclerotia were disinfected in 1: 1000 solution of corrosive sublimate for twenty minutes, washed in sterile distilled water, placed in a moist chamber and subjected to intermittent light. At the end of ten days, considerable development of mycelium had taken place and, a day or two later, the first development of the fruiting structures was observed. After twenty days, the fruiting structures were very definitely those of a resupinate *Poria* (PLATE 11). The pores were irregular, 2–4 mm.

in depth, at first creamy-white in color, later changing to a chocolate brown. The basidia and the basidiospores were identical with those described by Wolf. In the meantime, the remaining sclerotia were sterilized on the surface, opened aseptically, and plantings of the white starchy interior were made on poured potato agar plates under aseptic conditions. Fungous mycelium appeared on each of the plates after 36 hours. The fungus completely covered the surface of the agar in the petri dishes in five days at room temperature and at several places in each dish compact masses began to develop. These masses later proved to be the beginning of the development of the fruiting structures. In another week the fruiting structures were mature (FIG. 1), being identical with those developed on the sclerotia in the moist chamber. The appearance and measurement were identical with those in the description of *Poria Cocos* given by Wolf. These cultural methods have been repeated three times with additional sclerotia obtained during the past three years and in each instance the perfect fruiting stage has been developed on one or more of the specimens.

QUALITIES AND CONSTITUENTS

Storer (**41**) stated that the contents of the sclerotia were poor in nitrogen. Prillieux (**32**) stated that the contents gave no cellulose reaction. Schrenck (**35**) and Braconnet (**5**) concluded that the bulk of the inner substance was pectose, the former adding that there was no glutin and that it was largely composed of a substance which he called sclerotin. Torrey (**42**) stated that this sclerotin was identical with "pectous substances" which he later called pectose. According to Gore (**20**), chemical analyses have been made of these sclerotia by the University of Virginia, by Storer (**41**) of the Bussey Institute, and by Brown (**6**) of the U. S. Department of Agriculture. He concludes that less than 1% of a sclerotium is nutritious, that they show an absence of starch and have very little food value. He also states that he knows of no source having such a high pectin content. The three analyses are shown in the following table:

	U. S. D. A.	Bussey	U. of Va.
Moisture at 110° C.	12.97	14.57	10.70
Ash	.24	.24	3.64
Albuminoides	.79	1.38	.78
Carbohydrates	79.88	73.73	75.25
Fatty substances	.35	.34	—
Crude cellulose	5.77	9.80	3.76
Mineral			3.64

SUMMARY

The sclerotia of *Poria Cocos* (Schw.) Wolf occur in Florida, especially in the sandy soils. The fruiting stages were developed in pure culture from portions of the inner contents of the sclerotia removed aseptically and planted on poured agar plates. The pores, basidia and spores, in structure, size, shape, color and content, corresponded well with descriptions given by Wolf. The common and scientific names applied to the sclerotium of this fungus since 1722 are given, with the synonyms listed. The term tuckahoe, formerly applied to all tuberous, terrestrial growth, is suggested for the bulbous rootstalks of phanerogamic plants only. The fungous tubers should be grouped under the term sclerotia, when their fruiting structure is unknown, and classified according to the fructifications they are shown to produce. Weathered and partially disintegrated fruiting structures similar to those artificially developed, resembling a *Poria*, were observed in nature on the cortex of several sclerotia.

The following new hosts of the fungus are reported from Florida: magnolia, *Magnolia grandiflora;* grapefruit, *Citrus paradisi;* sweet orange, *Citrus sinensis;* oak, *Quercus* sp., and eucalyptus, *Eucalyptus* sp. (FIGS. 2–5).

FLORIDA AGRICULTURAL EXPERIMENT STATION,
GAINESVILLE, FLORIDA

EXPLANATION OF PLATE 11

FIG. 1. Fruiting structures developed in moist chamber on sclerotium found attached to orange tree roots. *B*. Greater magnification showing pore development.

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AN UNDESCRIBED SPECIES OF MACROPHOMA AND OF VOLUTELLA OCCURRING ON PACHYSANDRA TERMINALIS

W. G. Hutchinson

(With 4 Text Figures)

PART 1

During the latter part of 1925 the attention of the author was directed to diseased specimens of *Pachysandra terminalis* Sieb. and Zucc. received from Yorktown, Virginia. The plants were found to be infected with *Macrophoma* species and *Volutella* species hitherto undescribed.

The *Macrophoma* on *Pachysandra*

The *Macrophoma* produces small black pustules on the dead or partially dried stems. No definite cankers are formed. No hypertrophy or atrophy of the stem is evident.

Morphology

The Pycnidia:

The pycnidia are formed singly in the cortical region of the stem. They are globose to ovoid and 200–250 μ by 150–175 μ. The pycnidial wall is 5–10 μ thick.

The pycnidium develops subepidermally from a mass of mycelial threads. The outer layer of the pycnidium is composed of a mass of subhyaline or light brown mycelium and some disintegrating host cells. Within this is a second layer several cells in thickness composed of a dark brown mass of mycelium. This thick dark layer borders upon a narrow layer of subhyaline, pseudo-parenchymatous fungous tissue. The hyaline layer of thin-walled cells bearing the hyaline conidiophores composes the inner layer of the pycnidial wall.

As the pycnidium matures (FIG. 1), the epidermis is ruptured and rolled back and the pycnidia become erumpent, causing the black pustules. The ostiole is very small or entirely wanting.

The Spores:

The spores are formed singly on hyaline conidiophores approximately 10 μ long. The spores are one-celled and vary in

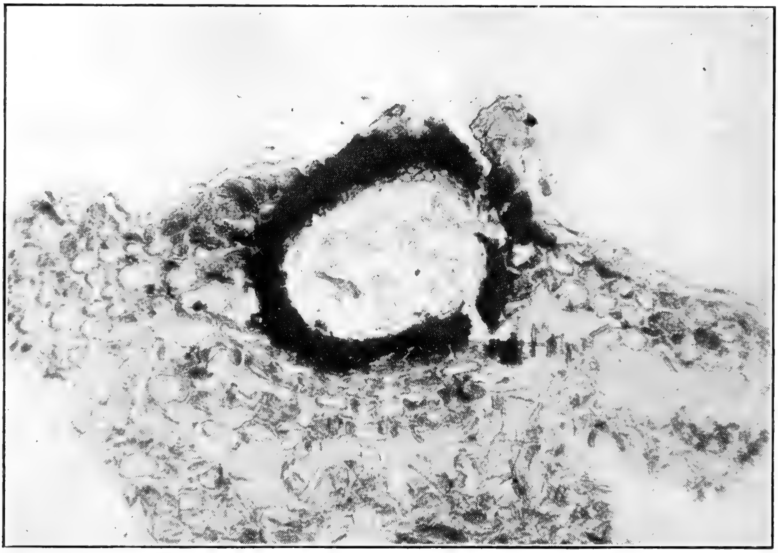

FIG. 1. Photomicrograph of portion of the cross-section of the stem of *Pachysandra terminalis* showing a mature pycnidium of *Macrophoma Pachysandrae*, $\times$ 400.

color from pure hyaline to an olive or dilute brown. They vary in length from 11.8 to 18.3 μ and in width from 3.9 to 9.8 μ. The spore wall is from 1 to 2 μ thick.

One hundred spores from fresh specimens were accurately measured for length and width. They were mounted in a mounting medium made according to the following formula:

Potassium acetate	10 gm.
Distilled water	500 c.c.
Erythrosin	10 gm.
Glycerine (pure)	200 c.c.
Ethyl alcohol 95%	300 c.c.

Biometrical calculations were made from the measurements and the following constants were derived:

ANALYSIS OF BIOMETRICAL DATA FOR LENGTH OF SPORES OF *Macrophoma* ON *Pachysandra*

Standard deviation	00.741
Arithmetical mean	14.095
Correction	00.1525
Mean	14.2475
Standard range	13.51–14.99 μ

ANALYSIS OF BIOMETRICAL DATA FOR WIDTH OF SPORES OF *Macrophoma* ON *Pachysandra*

Standard deviation	0.698
Arithmetical mean	5.68
Correction	0.00
Mean	5.68
Standard range	4.98–6.38 μ

In about four hours after sowing on a hanging-drop slide the spores germinate readily, usually forming a single germ tube.

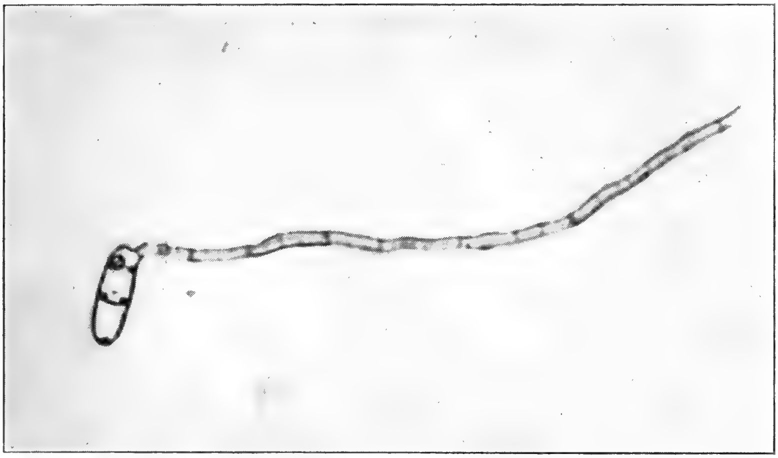

FIG. 2. Photomicrograph of germinating spore of *Macrophoma Pachysandrae* showing the formation of a septum in the spore at the time of germination, × 1350.

Immediately preceding germination the spores sometimes develop two large vacuoles and occasionally a septum forms between these (FIG. 2). The usual type of germination is unipolar or bipolar (FIG. 3). Unilateral germination is common and bilateral is very rare.

At 28° C., eighteen hours after sowing, spores showed the following results with regard to the regions of germination:

Unipolar	358	57.2%
Bipolar	162	25.9%
Unilateral	105	16.8%
Bilateral	1	00.1%

The germ tube continues to grow for some time as a continuous tube with very little branching (FIG. 3, 16). Occasionally a union occurs between the germ tubes of two spores germinating side by side (FIG. 3, 13).

Taxonomy

The pycnidia of this fungus are papillate, separate, smooth, and do not form spots on the leaves. The conidia are one-celled, hyaline, ovoid to oblong, and muticate. All these characters distinguish the fungus as a *Phoma* or a *Macrophoma* (**1**, **4**).

A very unsatisfactory criterion is at present used to distinguish *Phoma* and *Macrophoma*. The fungus having spores over 15 μ in length is considered a *Macrophoma* and that having spores less than 15 μ in length is considered a *Phoma* (**1**). The standard range of the spore lengths of the fungus under consideration is 13.15–14.99 μ. If this alone is considered, the fungus should be classed as a *Phoma*. Since, however, one spore measured 18.3 μ in length and several measured slightly over 15 μ, the fungus might well be classed as a *Macrophoma*.

Pachysandra terminalis was introduced into this country from Japan. No reference could be found to any fungus reported on this species. A *Phyllosticta* was found reported (**2**) on a closely related species, *P. procumbens* Michx. The spore measurements reported were 4.5–6 $\times$ 1 μ. Those for the *Macrophoma* are 11.8–18.3 $\times$ 3.9–9.8 μ. These measurements show that the two fungi could not possibly have been confused.

No *Macrophoma* of corresponding spore measurements could be found reported on any genus among the Buxaceae. A careful search of the literature concerning species of *Macrophoma*, *Phoma*, and *Phyllosticta* occurring on any of the Buxaceae has been made but no similar fungus could be found. It has been definitely concluded, therefore, that this fungus is a new species.

The fungus has been named **Macrophoma Pachysandrae** n. sp. It has the following characteristics:

Pycnidiis gregariis, fuscis, globosis-ovoideis, subepidermicis, denique erumpentibus, 200–250 × 150–175 μ.

Sporulis oblongis, continuis, hyalinis vel dilute brunneis, non vel 2 guttulatis, 11.8–18.3 × 3.9–9.8 μ. Basidiis filiformibus, continuis, hyalinis.

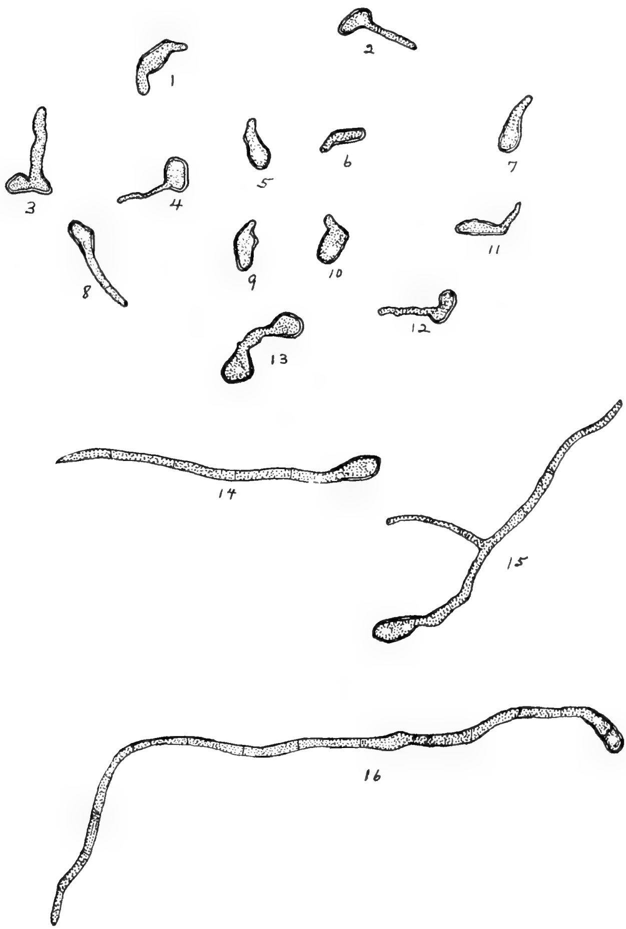

FIG. 3. Camera lucida drawings of germinating spores of *Macrophoma Pachysandrae*, × 420. Fig. 1–13 inclusive show spores four hours after sowing; fig. 14–15 inclusive, eight hours after sowing; fig. 16, ten hours after sowing. Fig. 13 shows two spores the germ tubes of which have united.

Physiology

The Mycelium:

The mycelium of *Macrophoma Pachysandrae* is hyaline with a slight suggestion of a brownish pigmentation in the cell wall. In culture the older mycelium en masse has a brown color. The mycelium is found to be intracellular in the cortex and epidermis.

From the inoculations made upon injured and uninjured host tissues it has been found that the mycelium enters the plant not necessarily through wounds but probably through stomata as well.

Cultures:

Cultures of *Macrophoma Pachysandrae* were grown on malt, potato, corn meal, and prune agars. On malt agar plentiful mycelium was soon developed but the fruiting bodies were formed in small numbers and very slowly. On corn meal agar the mycelium grew much more slowly and fruiting bodies were formed only after several weeks. On potato and prune agars the mycelium grew very slowly and no fruiting bodies were formed.

The optimum temperature for germination of spores and for growth of mycelium was found to be 28° C.

Pathogenicity

The host becomes infected by the fungus through wounds or stomata. The mycelium, after penetration of the host tissue in this manner, extends intracellularly through the cortical and epidermal regions of the stem.

Living, wilted, and dead plants of *Pachysandra terminalis* were inoculated with both spores and mycelium of *Macrophoma Pachysandrae*. On one set of plants to be used for inoculation the epidermis was cut in several places with a sterile scalpel. One series of inoculations was made by spraying the plants with a spore suspension in distilled water. Another series was made by transferring a small amount of agar containing the mycelium to a wound in the stem and covering the area with moist cotton. All the inoculated plants as well as the controls were kept in moist chambers.

After a month's time the plants were examined. The fungus was found to be present only on the dead and nearly dry stems.

The presence of the fungus was not limited to the wounded plants. No results were obtained from the inoculations made with mycelium. The results of the inoculations thus far indicate that the fungus is to be regarded as a saprophyte only.

Life History

The perfect stage of this species of *Macrophoma* has not been determined. The conidial stage is known to occur in the field from June until October. This stage was also obtained in culture and on *Pachysandra* plants in moist chamber throughout the winter at a temperature as low as 10° C. No artificial conditions created in the laboratory brought about the formation of a perfect stage. Under what conditions the perfect stage will form and what this stage is are as yet unknown.

PART 2

THE *Volutella* DISEASE OF *Pachysandra*

This species of *Volutella* has been found to produce a disease only upon *Pachysandra terminalis*. The fungus by cross inoculations has been made to grow upon *Buxus sempervirens* but without causing any definite disease symptoms.

Pachysandra terminalis is a widely grown and important nursery plant. Although this disease has not been shown to kill the plants, it does render them very unsightly. This disease can, therefore, be said to be of some economic importance. Up to the present time it has been reported only from Yorktown, Va.

As the specimens were received from the field, the symptoms of the disease were a constriction of the stem and a partial or total browning of the leaves. These symptoms are not always apparent in inoculated material but are found to some extent. The fungus is also found to grow upon browned areas on the leaves of inoculated plants in some few cases.

The mycelium of the fungus lives intracellularly in the epidermis and cortex of the stem. The cortex cells become devoid of chlorophyll. The cells of both cortex and epidermis become more or less shrunken and distorted from a loss of nourishment and water.

THE CAUSAL ORGANISM

Morphology

The Sporodochia:

The sporodochia are seashell pink (**3**) in color and approximately 5–6 mm. in diameter. They are sessile or rarely stipitate. At the base of the sporodochium arise numerous light brown setae. The setae vary in length from 250 to 450 μ and in width from 4 to 7 μ. They are 3- to 7-septate and pointed at the ends. The wall of the seta is approximately 0.5 μ thick. About 20 μ from the base of the setae the walls become very thin and the setae gradually taper down to a point.

The formation of the fruiting bodies was studied from cultures only. Here it was found that small tufts of mycelium were formed. These gradually increased in size and were sometimes slightly raised from the surface of the agar by the developing stalks. The setae are usually formed after the sporodochium has matured. Their formation results from the outpushing of modified thick-walled mycelium.

The Spores:

The spores are formed in great numbers on long hyaline conidiophores by the pinching off of terminal segments of the conidiophores. The spores vary in length from 2.3 to 6.1 μ and in width from 0.9 to 2.4 μ. En masse the spores have a pinkish brown hue although individually they are hyaline. They are filled with granular protoplasm and have a very thin wall.

One hundred spores from fresh material were accurately measured for length and width. The same mounting medium was used as described above. The following constants were obtained:

ANALYSIS OF BIOMETRICAL DATA FOR LENGTH OF SPORES OF *Volutella* ON *Pachysandra*

Standard deviation	0.65
Arithmetical mean	4.57
Correction	0.07
Mean	4.64
Standard range	3.99–5.29 μ

ANALYSIS OF BIOMETRICAL DATA FOR LENGTH OF SPORES OF *Volutella* ON *Pachysandra*

Standard deviation	0.48
Arithmetical mean	1.82
Correction	0.00
Mean	1.82
Standard range	1.34–2.3 μ

From eighteen to twenty hours after sowing on a hanging-drop slide the spores begin to germinate. A large vacuole is usually

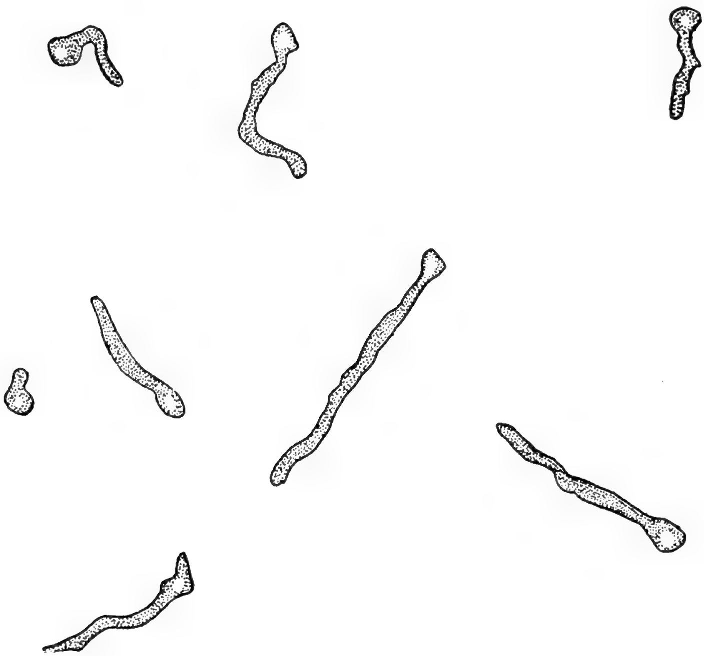

FIG. 4. Camera lucida drawings of germinating spores of *Volutella Pachysandrae*, × 660

formed previous to the extrusion of the germ tube. The germ tube grows to considerable length before branching and may develop several vacuoles (FIG. 4).

Taxonomy

The fact that the fruiting body takes the form of a globose-sessile sporodochium places the fungus among the Tuber, culariaceae. The sporodochia have numerous setae at the margin

and the spores are one-celled and hyaline. The fungus should, therefore, be classed as a *Volutella*.

A careful search of the literature concerning the *Volutellas* occurring on any genus among the Buxaceae has been made. None has been found corresponding in every detail to this fungus. It has been concluded, therefore, that this fungus is a new species.

The fungus has been named **Volutella Pachysandrae** n. sp. It has the following characteristics:

Sporodochiis gregariis, sessilis vel stipitatis, globosis, hyalinis-roseis, minutis 5–6 mm. in dia.; setis brunneis-hyalinis, 3–7 septatis, 250–450 $\times$ 4–7 μ.

Conidiis hyalinis, continuis, oblongis, 2.3–6.1 $\times$ 0.9–2.4 μ.

Physiology

The Mycelium:

The hyaline to light brown mycelium gains entrance to the host tissues through stomata or wounds and lives intracellularly in the epidermis and cortex. It is profusely branched and contains numerous vacuoles.

Cultures:

Volutella Pachysandrae grows and fruits most readily upon potato agar. Fruiting bodies and profuse mycelium are formed in two or three days. Interesting color reactions were observed in these cultures. Especially at the edge of the colonies the mycelium became a Corinthian purple (**3**). The developing fruiting bodies varied in color from white to light buff, cream color, and seashell pink (**3**).

On corn meal agar this fungus forms fruiting bodies in two or three days but there is very slight growth of mycelium. On prune agar and malt agar the mycelium grows readily but fruiting bodies are formed very slowly.

The optimum temperature for spore germination and for growth of mycelium was found to be 28° C.

Pathogenicity

The fungus gains entrance to the host through the stomata and especially through wounds. The mycelium lives within the cells of the epidermis and cortex.

Several sets of inoculations were made upon living, wilted, and dead plants. These inoculations were made by spraying with a spore suspension in distilled water and the plants were then placed in moist chambers. On some of the plants the leaves and stems were bruised and cut with a sterile scalpel before inoculations were made.

After two weeks the plants were examined. Those which were dead or wilted, both injured and uninjured, were found to be infected. The living plants were in most cases healthy. Fruiting bodies were present, however, on some of the living plants which had been cut or bruised. On one of these a characteristic constriction was formed which encircled the stem. On the constriction and the area adjacent to it were found numerous fruiting bodies of the *Volutella*. Irregularly defined brown areas developed on some of the bruised leaves. Numerous fruiting bodies of the *Volutella* were produced in the region of the wound. Cultures of *V. Pachysandrae* were obtained from the inoculated plants.

The results of the inoculations show that the fungus is parasitic to some extent. It does not develop on a normal living plant but will develop if the plant becomes weakened or wounded in any way. It may well be considered a wound parasite.

A series of cross inoculations were made with this fungus and *Volutella Buxi* Berk. upon *Pachysandra terminalis* and *Buxus sempervirens*. It was found that *V. Pachysandrae* would fruit upon the dead or dry leaves of *Buxus* but produced no disease symptoms. *V. Buxi* also fruited upon the dry leaves and stems of *Pachysandra* but produced no symptoms of disease.

Life History

The perfect stage of this *Volutella* has not as yet been determined. The conidial stage has been found in the field from June to October. In the laboratory the conidial stage only has developed throughout the winter in culture and on the inoculated plants.

Summary

Macrophoma Pachysandrae n. sp. has been found on *Pachysandra terminalis*, causing black pustules but no definite cankers on the dead or partially dried stems.

The pycnidia are globose to ovoid, 200–250 × 150–175 μ, and are formed singly in the epidermis and cortex of the stem.

The hyaline to light brown spores are formed on short hyaline conidiophores. The spore measurements are 11.8–18.3 × 3.9–9.8μ. The standard range is 13.51–14.99 × 4.98–6.38 μ. During germination the spores usually send out a germ tube at one or both ends. A septum sometimes forms in the germinating spore. The optimum temperature for spore germination is 28° C.

The mycelium lives intracellularly in the cortex and epidermis. The optimum temperature for growth of the mycelium is 28° C. The best growth is obtained on malt agar.

The fungus enters the host through stomata or wounds. Inoculations thus far indicate that the fungus is a saprophyte.

The perfect stage has not been determined.

Volutella Pachysandrae produces a diseased condition in the stems and sometimes in the leaves of *Pachysandra terminalis*. A constriction is formed on the stem. Irregular browned areas appear on the leaves.

The sessile to stipitate sporodochia are seashell pink in color and average 5–6 mm. in diameter. The setae measure 250–450 × 4–7 μ and are 3- to 7-septate.

The spores are hyaline and single-celled. They measure 2.3–6.1 × 0.9–2.4 μ. The standard range is 3.99–5.29 × 1.34–2.3 μ. A large vacuole is usually formed at the time of germination. 28° C. is the optimum temperature for spore germination.

The mycelium is intracellular. 28° C. is the optimum temperature for growth of the mycelium. The fungus shows the best and most rapid growth on potato agar.

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AN ANCIENT ROMAN TOADSTOOL CARVED IN STONE

John W. Harshberger

(With 1 Text Figure)

About 100 A.D., the Roman emperor, Trajan, ordered the legate, P. Munatius Gallus, commander of the Third Legion, to found the City of Thamugadi (Timgad) at the foot of the Aures mountains in eastern Algeria, as the outpost of Roman power in North Africa to guard the empire against the native Berber tribes (Barbarians). The town saw its prime in the second half of the Second and in the Third Century, passing later through trying vicissitudes until it was destroyed and burned by the hostile Berber tribes of the Aures mountains in 534 A.D. It was finally abandoned at the close of the Byzantine domination, and the ruins were gradually buried under the desert sands and outwash from the mountains with the exception of Trajan's arch, and the entombed town remained in almost complete oblivion for twelve centuries until the French government in 1880 began the excavation of the ruins. The city has now been practically uncovered and the visitor is shown the theater, the library, the hot and cold baths, the capitol, Trajan's arch and the market places.

The writer on a visit to the forest of Atlas cedar at the Col de Telmet, west of Batna, Algeria, made an automobile trip across the desert from Batna to Timgad, thirty-seven kilometers away, on July 22, 1928. The ruins at Timgad were found to possess great interest as showing the advanced architectural and engineering skill of the ancient Romans. Here in the chief market place, which was originally surrounded by colonnades, were found two large blocks of stone, which had been carved to form part of the architectural decorations of the colonnades. One large block had been decorated with a scroll of grape vines with bunches of grapes. The other one was characterized by a design of *Acanthus* leaves surrounding a centrally placed stone toadstool (Fig. 1), carved so that the gills and related stipe with basal

volva are clearly shown. The stone figure has been identified as a toadstool, although with its volva, it probably represents some poisonous, pileate, lamellate, fleshy toadstool known to the ancient

FIG. 1. Ancient toadstool carving

artist, who designed the architectural ornamentation of the Timgad market place. Do we not have in this stone carving the earliest known representation of a fleshy, gill-bearing fungus, dating back to the second century A.D.?

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NOTES ON THE HYDNACEAE [1]

Howard J. Banker

Some years ago the writer published a series of papers (**3**) which were intended as a preliminary study to a monographic treatment of the family of the Hydnaceae. That work was interrupted by a change of location necessitating a hasty packing of all herbarium material and notes as was supposed for only a few months but years have passed and only recently has it been possible to again have access to this material. In this period circumstances have so changed that it is improbable that the work can ever be continued as first planned. It has seemed, therefore, desirable to place on record in this more informal way the results of some of these studies which had been made yet are not in all respects ready for publication.

The resupinate Hydnaceae are very difficult to deal with on their own account and especially so in view of the prevailing taxonomic treatment. A multitude of species have been inadequately described and have been discriminated one from the other by what seem to the writer as extremely superficial and inconstant characters. The so-called "B. & C." species have especially added to the difficulties of properly segregating our American forms. The study of the original collections gives little aid in clarifying the situation so long as one's mind is under the incubus of the older taxonomic conceptions. I believe that the Friesian taxonomy itself in respect to these forms must be radically revised before we can find a natural basis for the discrimination of the species.

The great bulk of the resupinates are commonly described under the generic name of *Hydnum* as a convenient catch-all having scarcely more than a family significance. As the writer has restricted that term to a group of fleshy pileate forms of which the type is *Hydnum repandum* L. (**2**, p. 104), to be self-consistent he is under the necessity of assigning to the resupinate forms some

[1] Investigation prosecuted with the aid of a grant from the Esther Herrman Research Fund of the New York Academy of Science.

other generic name or names. His studies, however, have not proceeded far enough to warrant ascribing a definite generic status to most of the species or to decide in all cases what older names must be retained under a new system. In fact, specific limitations are in many cases ill defined and hazy. Some fundamental questions apparently can be settled only by cultural studies.

After separating out a few fairly well-marked genera, the remaining resupinates seem to fall chiefly into two groups characterized, on the one hand, by a sub-gelatinous to waxy consistency of the mycelial substance and, on the other, by a dry, compact to floccose mycelium. That one or more genera may be further segregated from these forms on the basis of constant hyphal and spore characters seems possible but can not be definitely asserted by the writer.

What names may be applied to these groups must first depend on which of the older generic types are included in each segregation, a problem that is far from easy of solution. It seems possible that the Friesian name *Grandinia* should be retained for one of the above described groups by emphasizing the character *ceraceum* rather than *granulosum* in Fries's original description of the genus (**5**, p. 527). It is to be noted that in his descriptions of the seven species under this genus Fries mentions, as the first named characteristic of the first five species, "ceracea" or "subceracea." Yet it is probable that he was prone to recognize the genus himself by the more superficial character of the granulose hymenium and certainly that has been the prevailing conception in all later work. The writer, however, believes that the nature of the substance is a more natural character.

One genus which we feel fairly confident may be segregated from these resupinate forms as based on well-defined and fundamental characters is *Odontia* of Persoon, not *Odontia* of Fries. For the latter we have long since suggested the name *Etheirodon* (**1**, p. 441) but we are not now satisfied that the genus is of good standing, at least in its prevailing conception as primarily characterized by crested or penicillate verrucae or warts. If, however, we should revert to the Friesian emphasis, "*Resupinato-effusae, aridae nec ut praecedentes*" [Grandinia] "*ceraceae*" (**5**, p. 528), in

our conceptions of its fundamental character, it might be found to be an available name for more or less of the forms described above as having a "dry, compact to floccose substance." As to the *Odontia* of Persoon there appears to be no question of its validity although it is probable that its author would hardly recognize his genus under our definition. However that may be, by chance or otherwise, he established the genus, according to our modern rules, on a form which we now know to be quite distinct from the usual run of resupinate hydnums and wholly removed from the *Odontia* of Fries. In this greatly restricted sense we may accept *Odontia* Persoon as a valid genus.

ODONTIA Pers. Neues Mag. Bot. **1**: 110. 1794

The genus *Odontia* Pers. was established on *Odontia ferruginea* and *O. nivea*. The first named species must be considered the type of the genus. Later Persoon discarded the genus *Odontia*, referring the species as a subgenus to the older genus, *Hydnum* (**7**, p. 560). It is evident that Persoon intended his genus *Odontia* to include the resupinate forms segregated from the genus *Hydnum*.

In 1815 Fries took up the name *Odontia* as a subgenus of *Hydnum* (**4**, p. 149) probably in the Persoonian sense, but in 1836–38 (**5**, p. 528) he published the name as a genus in a greatly restricted sense that wholly excluded the original species on which Persoon founded his genus and even excluded the species which he had himself included in his former subgenus *Odontia*. In this more specialized Friesian use the genus has ever since been understood.

The Persoonian conception seems to us too broad but in restricting the scope of the genus it is evident that the name should be retained for that segregation which includes *Odontia ferruginea* Pers. So far as our understanding of the species is concerned the genus appears to be monotypic, and may be characterized as follows: Plants resupinate-effused; subiculum dry, tomentose, dark colored; spores ovoid to globose, tuberculate, fuscous; hyphae thick walled, colored. The genus is very near *Hydnellum* Karst., from which it differs chiefly in being wholly resupinate and effused.

ODONTIA FERRUGINEA Pers. Neues Mag. Bot. **1**: 110. 1794

Hydnum tomentosum Schrad. Spic. 177. *pl. 4. f. 2.* 1794; not *H. tomentosum* L. Sp. Pl. **2**: 1178. 1753.

Hydnum ferruginosum Fries, Syst. Myc. **1**: 416. 1821.

Hydnum crinale Fries, Epic. Syst. Myc. 516. 1836–38.

No type specimen of *Odontia ferruginea* Pers. was to be found at Leyden. The species, however, is so very distinct from other resupinate forms of the Hydnaceae that there has never been any doubt expressed as to its identity. The synonymy has arisen chiefly from other causes.

Hydnum tomentosum Schrad. was described in the same year as *Odontia ferruginea* Pers. and there might be some question as to priority of name but for the fact that Schrader's name is untenable, having been previously used by Linnaeus for a distinctly stipitate form.[2] So far as the writer knows there is no type specimen of Schrader's species but his very full and exact description applies perfectly to the plants which we consider to be typical of *O. ferruginea* Pers. and to no other. We have not seen Schrader's figure as the copy of the Spicelegium to which we have had access lacked the plate. The citations of Fries and other authors also confirm our belief that the two species are identical.

Hydnum ferruginosum Fries was understood by Fries to be the same as *H. tomentosum* Schrad. and *O. ferruginea* Pers. His description in part is very nearly verbatim from Schrader and both Schrader's and Persoon's names are cited as synonyms. As Schrader's name was already used for a Linnaean species recognized by Fries and as Fries had used the name *ferrugineum* for a stipitate species of his own,[3] he discarded both names and coined one of his own. As this is in violation of the law of priority, we would restore the Persoonian name.

There was no type specimen of *Hydnum ferruginosum* Fries at Upsala. A specimen collected by Karsten in 1864 was placed under this name, but was clearly *Asterodon ferruginosum* Pat., as was noted on the sheet in manuscript notes by Bresadola. We have little reason to suppose that this specimen represents the *H. ferruginosum* of Fries although its color is much more sugges-

[2] See MYCOLOGIA **5**: 64. 1913.

[3] See MYCOLOGIA **5**: 197. 1913.

tive of Fries's later description, "fulvo-ferrugineis" (**5**, p. 516) than are the plants which we refer to *O. ferruginea* Pers.

Hydnum crinale Fries was represented at Upsala by a specimen that appeared to be identical in every respect, including spore characters, with the plants which we consider to be *O. ferruginea* Pers. We can not be sure that this specimen is the type of the species. The descriptions of *H. crinale* and of *H. ferruginosum* as given in the Epicrisis and repeated in Fries's later work, "Hymenomycetes Europaei" (**6**, p. 613), seem to apply to our specimens the one about as well as the other and neither is wholly accurate. Thus the expression "aculeisque umbrinis unicoloribus" used of *H. crinale* describes the color in our plants much more closely than does the expression "fulvo-ferrugineis" used of *H. ferruginosum*, while on the other hand the terms "aculeisque confertis conico-subulatis acutis," used in respect to *H. ferruginosum*, is more applicable to our plants than the phrase "aculeisque longis gracillimis" used for *H. crinale*. Yet it is only in these particulars that the two descriptions materially differ.

Another species, first described as: *Grandinia coriaria* Peck, Bull. Buffalo Soc. Nat. Sci. **1**: 61. 1873,[4] may perhaps be referred to this genus if Peck's interpretation was correct. I have never been able satisfactorily to demonstrate basidia in specimens commonly referred to this species. It seems possible that it does not belong to the Basidiomycetes at all and may be one of the Dematiaceae of the Fungi Imperfecti. This is quite beyond the range of my studies but shows to what lengths we may be led when guided only by gross superficial characters.

I have not been satisfied that *Grandinia coriaria* Peck is distinct from

Grandinia tabacina Cooke & Ellis, Grevillea **9**: 103. 1881.
Zygodesmus granulosus Peck, Bot. Gaz. **6**: 277. 1881.

[4] Saccardo (Syll. Fung. **6**: 503) cites for the species "Peck 26 Rep. p. 71," that is, "Report of the Botanist from the Twenty-sixth Annual Report on the New York State Museum of Natural History, for the year 1872." The fact is the Botanist's report was not issued until April, 1874, even then "in advance of the report," as stated on the separate. In the meantime Dr. Peck had described the species in July, 1873, as cited in the text above.

Zygodesmus rubiginosus Peck, Ann. Rept. N. Y. State Mus. **30**: 58. 1879.

Zygodesmus hydnoideus Berk. & Curt. Grev. **3**: 112. 1875.

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AN EASY METHOD FOR THE STUDY OF SIMPLE HYPHALES IN CULTURES[1]

R. Ciferri

(With 2 Text Figures)

For several years I have been employing an easy method for the study of the morphological characteristics of Mucedineae, Dematiaceae and "Mycelia sterilia" in cultures, which has given me excellent results and to which I refer as follows.

Said method is, in part, a perfection of the well-known drop culture of van Tieghem and Le Monnier, and, in part, of the Unna method, of dry culture.[2] It has the advantage over the first one in that it is much easier, it does not produce contractions in the hyphae when it dries, and it does not alter in the least the form and disposition of the different organs. The minimum care required for an ordinary agar or gelatine culture is sufficient to guarantee against any contamination, which is not true of the drop culture method; the process of fixation, staining, mounting, etc., does not alter the position of the organs, and the mycological materials solidly attached to the cover glass are not wasted in the immersions and manipulations.

It has the advantage over the Unna method (or the "lames sèches" method of Beurmann and Gougerot) of allowing a much more ample development on the surface, and, later, securing more satisfactory results by allowing the use of solid nutrient media as desired, results difficult to obtain with the Unna method.

I must say that not all the Hyphales are equally adapted for cultivations by this method; those with aggregated fructifications, such as the Tuberculariaceae and the Stilbaceae, the simple Hyphales with erect fructification being less suited to this method, and on the other hand it is especially adapted to the

[1] Contributions of the National Agronomic Station of Moca, N. 54.

[2] For bibliographical references and description of methods, see Langeron, Précis de Microscopie, XVI, 1034, IVe Ed., Paris.

study of fungi whose development is principally mycelial, or whose fructifications are almost entirely mycelial. This method serves very well for the morphological and morphogenic study of

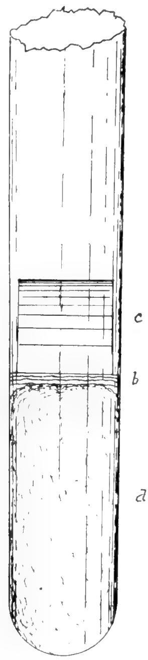

FIG. 1. Representation of the lower portion of culture tube with the cover glass. *a*, layer of raw cotton; *b*, triple layer of filter paper; *c*, cover glass. (Reduced.)

the pathogenic group of Dermatomycose fungi (Dermatophytae or Dermatomycetae) whose study by the ordinary method is frequently difficult.

In general, the method consists in making the fungus develop on a very thin layer of solid nutrient media in a moist chamber (so as to avoid the evaporation that would very rapidly dry the culture media) on a cover glass. For this purpose, cover glasses of the desired form are chosen, taking into consideration that up to a certain limit it is convenient to increase the size for the culture in tubes; and furthermore these culture tubes should be changed for Petri dishes as advised later.

Generally, squared glasses 20 mm. or less, because of the difficulty of finding culture tubes of a larger diameter, are employed.

The difference between the diameter of the tube and the size of the cover glass must be such as to permit the easy entrance into the tube, leaving same inclined (FIG. 1). For example, for tubes of 20 mm. in diameter, use cover glasses 18 × 18 mm. These cover glasses must be very clean, since a thin layer of grease would prevent the complete adherence of the nutrient medium. It is advisable then to wash them the last time with sulphuric ether. Then take culture tubes and put on the waxed extreme of the tube a plug of raw cotton about 30 mm. high, compressing lightly, and above place two or three disks of filter paper. In each tube place a clean glass, plug it as usual with cotton and sterilize all with dry heat. The tubes thus prepared are preserved together with the sterile material in accordance with mycological technic. Figure 1 represents the lower portion of the tube thus prepared.

When one wishes to prepare cover glasses for culture (attention is called to the fact that it is better for same to be recently prepared), a tube containing the agar or gelatine required is disolved and the contents of a Petri dish maintained at 60°–70° C. is poured; then put away the sterile glasses, warm them rapidly over a flame and make them float in the melted nutritive medium. In the tube, enough of distilled water is used to thoroughly wet the cotton and the filter paper. The cover glasses are taken with forceps and placed inside the tube until they are settled on the filter paper. The tubes thus prepared will be sterilized in the auto-clave and, if the nutritive medium is sufficiently fluid and the cover glasses hot, the excess medium that is strained on the filter paper will be insignificant; but if the results are contrary, no harm is done.

When the tubes are cooled, the fungus is transplanted on the surface that was wet with the agar or gelatine; the same is covered as usual, with a cotton cork and a rubber hood sterilized with mercury bichloride.

The fungus will develop on the surface of the glass; when the development is finished, uncover the tube and take out the cover glass. Generally for agar culture, the fungus can be fixed with alcohol; in certain cases, especially for culture on soft gelatine, the nutrient medium can be hardened with formaldehyde steam.

In the same manner, any cytological fixative can be employed; the cover glass thus prepared can be treated as desired. Usually the process is completed by dehydrating and mounting the object with Canada Balsam on a slide. In this case, there should

FIG. 2. Representation of the mounting of a cover glass with the fungus culture. *a*, slide; *b*, Canada balsam for the adheretion of the two glasses; *c*, cover glass with the fungus; *d*, Canada balsam interposed between the two cover glasses; *e*, cover glass for mounting. (Natural size.)

be interposed between the fungus and the upper surface of the cover glass a very thin layer of nutritive medium; but usually this is unnecessary. In case one wishes to make very careful observations as to cytological details, it is convenient to employ the mounting system drawn on FIGURE 2. On the slide is placed the dehydrated and stained cover glass with the fungus, interposing a drop of Canada Balsam between the slide and the free surface of the same, so that the surface with the fungus remains on the upper side. A second drop of Balsam is placed on the surface of the cover glass with the fungus and a second cover glass is placed on top of the first one.

For culture on large cover glasses, instead of culture tubes, there should be placed one or more of these on disks of wet filter paper in a Petri dish. In sterilization in the autoclave, the dishes must be inclined so as to drain off the possible excess of the nutrient medium from the cover glasses. This second method is not so satisfactory as the first one.

It is not advisable to use in the fungus nutrient media which form crystals that may interfere with the microscopical study. With certain biological stains, the culture media are lightly stained but generally this does not bother the microscopist.

If one wishes to keep the cover glasses with the fungus cultures unmounted, it can be fixed with alcohol, formaldehyde, or any other fixative, dried and put in melted paraffine. When desiring to use same, the paraffine may be dissolved with xylol and the cover glasses will be ready for final treatments.

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TABULATION OF ALTERNARIA AND MACROSPORIUM [1]

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Incomplete descriptions, mutations, secondary development of spores, dwarfing of spores in culture, and facultative parasitism resulting in large host ranges have caused great confusion in the classification of the species of *Alternaria* and *Macrosporium*.

This tabulation was compiled to make possible the classification of the species of these fungi used in inoculations (Young, **33**). The species in the table are arranged on the basis of minimum spore lengths.

The columns of family names and translated generic names serve as a convenient index to the plants bearing these fungi.

Monographic work of sufficient completeness, including pathological and physiological studies, will probably reduce to synonymy many specific names of *Alternaria* and *Macrosporium*. *Alternaria tenuis* Nees and *Macrosporium commune* Rabh. are difficult to separate. Elliott (**10**) placed the species of *Alternaria* in seven main morphological groups, and said that echinulation is not a constant character. He and Young (**33**) demonstrated the wide host ranges of these fungi in the laboratory and the greenhouse. Elliott clearly showed that the generic name *Macrosporium* should be abandoned because all the species of *Macrosporium* belong in *Alternaria* or *Stemphylium* because they have catenulate, sarcinaeform, or globose conidia. There is a laudable tendency to follow his emended description of *Alternaria*. *Macrosporium* is used here only because so many species were described under this name.

Before *Alternaria* is monographed, its species will continue to be classified on the useful bases of spore sizes and food plants.

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Now it is extremely difficult to classify these fungi because most of the specific descriptions are very incomplete. Roberts (**24**), Milbraith (**15**) and Rands (**22**) are among those who have written the few adequate descriptions. Plunkett (**20**) and Bonde (**2**) report mutations in species of *Alternaria*.

Young (**33**) measured the spores of many species and grew them in culture.[2] These measurements, given here for the first time as citation **34**, are based on both natural habitat and laboratory characters. They add to the list of host plants, and show that ranges of spore measurements are too small as given in the specific descriptions. The cultures supported the statement by Elliott (**10**) that *Alternaria* spores produced on culture media tend to be smaller than spores borne on their natural food plants.

Elliott (**10**) gave spore measurements of some species in his graphs; they are included in the table. Bolle (**1**) contributed to the knowledge of *Alternaria*.

The following species of *Alternaria* and *Macrosporium* (listed according to their reference numbers) were given descriptions so incomplete in the "Sylloge Fungorum" that they are practically useless: *Vol. 4:* species numbers 2M, 7M, 16M, 25M, 38M, 39M, 40M, 44M, 49M, 51M, 67M, 72M, 76M, 5A, and 6A. *Vol. 10:* numbers 2M, 13M, 18M, 24M, and 4A. *Vol. 14:* species number 8M. *Vol. 16:* numbers 3A and 4A. *Vol. 18:* numbers 5M, 7A, and 8A. *Vol. 22:* numbers 8M, 11M, 13M, 14M, 15M, 16M, 1A, and 7A. Since sizes of conidia were not given in the descriptions, these species could not be tabulated here.

TRANSLATION OF GENERIC NAMES INFLECTED IN LATIN

The deplorable custom of inflecting generic names in Latin descriptions has caused considerable bewilderment by altering many names so much that recognition is difficult and often doubtful. In these numerous cases the reader loses much time in determining the nominative singular forms of the inflected generic names. As examples, what are the translations of the following cases? (*a*) Genitive: *Cucumeris*, *Diptericis*, *Crotonis*, *Smilacis*, *Gyrinopseos*, *Dryadis*, *Dolichi*, *Ammi*, *Praedanthi*,

[2] The fungi were grown at 25° C. on agar prepared as follows: 50 g. of white corn meal were cooked in one liter of water for one hour, and then filtered. The filtrate was cooked with 13 g. of agar for 1.5 hr. at 100° C., and then centrifuged.

Iunci, *Sporotrichi*, *Phasiani*, etc. (*b*) Accusative: *Typham*, *Agaricum*, etc. (*c*) Ablative: *Fumagine*, *Dichaena*, *Allio*, etc. (*d*) Adjectival forms: *quercino*, *abietinis*, etc. Recognition of the nominative cases of these names depends more upon botanical familiarity with the genera than upon a knowledge of Latin. Fortunately, it is usually safe to guess that generic names with genitive endings in "-ii" have nominative endings in "-ium" instead of "-ius."

The difficulties caused by inflecting generic names could all be avoided easily by using the nominative singular case in some way like one of the following examples: (a) *Alternaria rugosa: habitatio-Lycopersicum*. (b) *Rosa*, *Triticum et Syringa ferunt Alternaria tenuis*. (c) *Hab. Solanum; in foliis; ad caules vivos*.

Since clearness is an important literary law, many readers of Latin descriptions are not taxonomists, and there should be response to the need of practical taxonomy and mycology for the applied sciences, it is hoped that the next botanical congress will discourage the inflection of generic names in subsequent descriptions.

EXPLANATION OF THE TABULATION

Column 1 contains the generic names of the plants on which the species of *Alternaria* and *Macrosporium* occur. The generic names given in Saccardo's "Sylloge Fungorum" are translated. Such old names as *Lappa* and *Negundo* are retained because they are used in the descriptions cited. Some common names are given because the descriptions lack generic names.

Column 2 contains the names of the families. Because species of *Alternaria* have ranges of food plants wider than present knowledge shows, old conceptions of some families are used. For example, Rosaceae includes *Prunus* and Saxifragaceae includes *Ribes*. Thus, they suggest more genera as food plants than the names Drupaceae and Grossulariaceae would do.

Columns 1 and 2 serve as a convenient index to the plants on which the fungi occur. Because the spore sizes of the species vary widely, it is wise to read the whole lists of the family and generic names, and later eliminate those too unlike the species being classified. Many other plants were described by Young (**33**) as being hosts under laboratory and greenhouse conditions.

Column 3 gives the lengths of the spores in microns. Many of these measurements include the spore beaks. While spore sizes constitute a fundamental basis for separating species, the ranges in spore sizes have been described so incompletely that strong consideration must be given to food plants in classifying these fungi.

Column 4 gives the widths of the spores in microns.

Column 5 contains references to the descriptions of the species. "A" means *Alternaria* and "M" means *Macrosporium.* For example, 4–2A means species of *Alternaria* number 2 in volume 4 of Saccardo's "Sylloge Fungorum"; 16–4M means species of *Macrosporium* number 4 in volume 16. Numbers in parenthesis refer to "Literature Cited." P.F. means Physiological Form of *Alternaria tenuis* as considered in citation **33**. Although the spores in culture were small, recent study decides that P.F. 7 was probably *A. crassa* and P.F. 15 was probably *A. Solani.*

(1)	(2)	(3)	(4)	(5)
Dianthus	Caryophyllaceae	8–90	5–25	(**10**)
Brassica	Cruciferae	8–59	5–19	4–2A (**10**)
Solanum	Solanaceae	10–22	7–12	11–12M
Amygdalus	Rosaceae	10–25	5–12	4–60M
Citrus	Rutaceae	10–40	8–25	(**19**)
Setaria (seed)	Gramineae	10–40	7–18	4–1A (**3**[3], **34**) P.F. 5
Citrus	Rutaceae	10–40	8–25	18–3A
Zea	Gramineae	10–60	8–20	4–62M (**32**, **34**)
Citrus	Rutaceae	10–47	5–15	16–1M
Brassica	Cruciferae	10–65	5–14	14–1A (**33**, **34**)
Wood	——	11–57	5–21	4–1A (**10**)
Avena	Gramineae	11–70	7–14	16–4M (**33**, **34**)
Valerianella	Valerianaceae	12–18	10–15	10–15M
Theobroma	Sterculiaceae	12–36	12–18	22–4M
Salvia	Labiatae	12–40	8–12	4–4A
Vitis	Vitaceae	12–24	6–9	4–59M
Suaeda	Chenopodiaceae	12–24	10–12	10–14M
Cucumis (fruit)	Cucurbitaceae	12–54	7–14	4–52M (**33**, **34**)
Cucurbita (fruit)	Cucurbitaceae	12–54	7–14	4–52M (**33**, **34**)
Sambucus	Caprifoliaceae	12–70	5–15	11–14M
Iris	Iridaceae	13–106	5–33	(**10**)A
Bird Nest	——	13–20		4–79M
Solanum	Solanaceae	13–57	3–19	(**10**)
Brassica	Cruciferae	13.4–70	6.5–14	(**15**)A
Cucurbita	Cucurbitaceae	13.5–47.5	9.5–17.5	(**23**)M
Iris	Iridaceae	14–35	8–20	4–75M (**33**, **34**)
Lycopersicum, et al.	Solanaceae	14–60	7–20	(**33**, **34**)A
Lycopersicum	Solanaceae	14–56	11–14	14–3A (**33**, **34**)
Abutilon	Malvaceae	14–54	8–18	10–2A (**33**, **34**)
Capsicum (leaf spot)	Solanaceae	14–70	8–15	4–32M (**33**, **34**)
Triticum (seeds)	Gramineae	14–50	7–14	4–1A (**33**, **34**) P.F. 1
Triticum (seeds)	Gramineae	14–33	7–18	4–1A (**33**, **34**) P.F. 2
Raphanus (leaf spot)	Cruciferae	14–40	7–14	4–1A (**33**, **34**) P.F. 6
Datura (leaf spot)	Solanaceae	14–40	7–18	(**21**, **33**, **34**) P.F. 7
Asparagus (stems)	Liliaceae	14–35	8–10	4–1A (**33**, **34**) P.F. 10
Syringa (leaf spot)	Oleaceae	14–50	7–18	4–1A (**33**, **34**) P.F. 13
Symphoricarpos (fruit)	Caprifoliaceae	15–35	7–18	4–1A (**33**, **34**) P.F. 9
Rosa (buds)	Rosaceae	15–36	8–15	4–1A (**33**, **34**) P.F. 11
Datura	Solanaceae	15–105	3–28	(**10**)A (**21**)A
Citrus	Rutaceae	15–25	1.7–2	18–1A
Paper	——	15–25		4–80M
Aster	Compositae	15–40	12–18	11–13M
Nicotiana	Solanaceae	15–25	10–12	(**28**)M
Pisum	Leguminosae	15–66	9–21	(**11**)A
Zea	Gramineae	15–72	9–20	4–62M
Lappa	Compositae	15–75		4–3M

(1)	(2)	(3)	(4)	(5)
Allium	Liliaceae	15–75		4–3M
Beta	Chenopodiaceae	15–75		4–3M
Phytolacca	Phytolaccaceae	15–75		4–3M
Lactuca	Compositae	15–75		4–3M
Festuca	Gramineae	15–93	6–18	16–3M
Stipa	Gramineae	16–18	14	(**25**)M
Cellulose	——	16–38	6–12	(**9**)A
Aesculus	Hippocastanaceae	16–40	8–27	10–9M
Pyrus	Rosaceae	16–60	9–13	(**24**)A
Allium	Liliaceae	16–70	10–20	4–69M (**33, 34**)
Ribes	Saxifragaceae	17–83	7–19	22–3A
Brassica	Cruciferae	17.5	12	14–6M
Salix	Salicaceae	18–20.5	7–9.5	(**7**)M
Many hosts	——	18–28	9–12	4–1M
Citrus	Rutaceae	18–28	9–12	4–1M
Capsicum	Solanaceae	18–28	9–12	4–1M
Cassia	Leguminosae	18–28	9–12	4–1M
Syringa	Oleaceae	18–28	9–12	4–1M
Nicotiana	Solanaceae	18–28	9–12	4–1M
Asparagus	Liliaceae	18–28	9–12	4–1M
Prunus	Rosaceae	18–28	9–12	4–1M
Platanus	Platanaceae	18–28	9–12	4–1M
Castanea	Fagaceae	18–28	9–12	4–1M
Platanus	Platanaceae	18–28	9–12	4–1M
Alnus	Betulaceae	(18–28)	(9–12)	(**32**)M
Beta	Chenopodiaceae	18–28	9–12	4–1M
Chenopodium	Chenopodiaceae	18–28	9–12	4–1M
Coffea	Rubiaceae	(18–28)	(9–12)	(**32**)M
Sterculia	Sterculiaceae	18–28	9–12	4–1M
Rhus	Anacardiaceae	18–28	9–12	4–1M
Yucca	Liliaceae	18–28	9–12	4–1M
Helianthus	Compositae	18–28	9–12	4–1M
Phytolacca	Phytolaccaceae	18–28	9–12	4–1M
Solanum Melongena (fruit)	Solanaceae	18–58	8–18	14–3A (**33, 34**)
Catalpa (leaf spot)	Bignoniaceae	18–54	10–27	4–42M (**33, 34**)
Phaseolus (pod)	Leguminosae	18–50	9–14	4–1A (**33, 34**) P.F. 8
Pyrus (fruit)	Rosaceae	18–40	11–18	4–1A (**33, 34**) P.F. 14
Viburnum (leaf)	Caprifoliaceae	18–36	8–14	4–1A (**33, 34**) P.F. 16
Capsicum (fruit)	Solanaceae	18–60	8–14	14–3A (**33, 34**)
Prunus	Rosaceae	19	10	18–10M
Onobrychis	Leguminosae	19–86	9.5–17	(**23**)A
Heracleum	Umbelliferae	20	9	14–6M
Wood	——	20	12	11–2A
Lotus	Leguminosae	20–28	16–19	14–12M
Panicum	Gramineae	20–30	10–12	14–21M
Lactuca	Compositae	20–30	10–15	4–19M
Eucalyptus	Myrtaceae	20–30	12–14	18–7M
Ricinus	Euphorbiaceae	20–30	12–14	4–23M
Galeobdolon	Labiatae	20–30	12–18	10–19M
Pelargonium	Geraniaceae	20–30	18–22	11–3M
Deinacanthon	Bromeliaceae	20–30	10–15	(**26**)
Quercus	Fagaceae	20–30	20	4–45M
Cucurbita	Cucurbitaceae	20–35		4–52M
Juncus	Juncaceae	20–35	5.5–14	14–4A
Wood		20–36		4–36M

(1)	(2)	(3)	(4)	(5)
Juglans	Juglandaceae	20–43	10–23	22–6A
Kentia (leaf)	Palmaceae	20–50	10–18	4–1A (**33**, **34**) P.F. 4
Ligustrum	Oleaceae	20–54	10–15	4–1A (**33**, **34**) P.F. 12
Lycopersicum	Solanaceae	20–60	9–14	4–31M (**33**, **34**) P.F. 15
Pelargonium	Geraniaceae	20–57	8.5–17	14–4M
Polytrichum	Polytrichaceae	20–60	7.5–15	10–26M
Vitis	Vitaceae	20–64	8–15	14–11M
Solanum	Solanaceae	20–70	10–20	10–21M
Bigelowia	Compositae	20–70	15–22	10–4M
Food	——	22	12	4–81M
Rubus	Rosaceae	22–25	9	10–5M
Pyrus (fruit)	Rosaceae	22–62	9–15	22–1M (**33**, **34**)
Hibiscus	Malvaceae	22–26	10–12	10–10M
Saponaria (leaf spot)	Caryophyllaceae	22–80	7–14	4–28M (**33**, **34**)
Dictamnus	Rutaceae	23–40	8–12	22–2M
Sonchus	Compositae	23–102	6–31	(**10**)A
Celosia	Amaranthaceae	24–26	14–18	18–4M
Thea	Ternstroemiaceae	24–28	10	22–5M
Trifolium	Leguminosae	24–28	12–18	10–16M
Sphaeropsis	Sphaerioidaceae	24–38	15–20	11–17M
Polypodium	Polypodiaceae	24–70	10–19	(**13**)A
Lagenaria	Cucurbitaceae	24–40	10–20	4–50M
Herbs	——	24–40	6–15	4–33M
Brassica	Cruciferae	25	7.5	14–1A
Crataegus	Rosaceae	25–33	16–20	4–47M
Collaea	Leguminosae?	25–35	10–12	(**26**)M
Citrus	Rutaceae	25–36	18–25	4–41M
Medicago	Leguminosae	25–35	16–18	18–1M
Urtica	Urticaceae	25–85	5–5.5	14–16M
Vitis	Vitaceae	25–45	10–12.5	14–2A
Carex	Cyperaceae	25–50		4–68M
Melilotus	Leguminosae	25–50	3–5	4–29M
Negundo	Aceraceae	25–50	10–12	14–10M
Clematis	Ranunculaceae	26–40	13	14–1M
Symplocarpus	Araceae	26–50	20–30	(**31**)M
Dianthus	Caryophyllaceae	26–100	13–38	(**8**)A
Dianthus	Caryophyllaceae	26–123	10–20	22–2A
Cirsium	Compositae	27–38	13–15.5	22–6M
Catalpa	Bignoniaceae	27–54	15–27	4–42M
Secalis	Gramineae	27–60	9–15	18–16M
Datisca	Datisceae	28	11–12	4–22M
Pyrus	Rosaceae	28	12	22–1M
Vitis	Vitaceae	28–30	15	11–4M
Cucumis	Cucurbitaceae	28–105	8–31	4–2A (**10**)
Lotus	Leguminosae	28–30	18–20	18–6M
Ustilago	Ustilaginaceae	29–67	8–12	10–27M
Brassica	Cruciferae	29–108	8–25	(**1**)A
Herbs	——	30	10	10–12M
Cassia	Leguminosae	30	12–16	4–58M
Glotidium	Leguminosae	30	15	4–55M
Gynerium	Gramineae	30	15	4–65M
Iris	Iridaceae	30–35	15–20	4–75M
Hedera	Araliaceae	30–35	18	4–6M
Euphorbia	Euphorbiaceae	30–35	18	4–6M
Evonymus	Celastraceae	30–35	18	4–6M

(1)	(2)	(3)	(4)	(5)
Many hosts		30–36	14–15	4–1A
Cassia	Leguminosae	30–72	16–20	10–3M
Allium	Liliaceae	30–40	12–15	22–9M
Quercus	Fagaceae	30–40	18	14–18M
Colutea	Leguminosae	30–45	12–18	4–56M
Arbutus	Ericaceae	30–45	23–32	11–1A
Aecidium	Pucciniaceae	30–50	10–12	10–28M
Cassia	Leguminosae	30–50	10–15	10–8M
Laminaria	Laminariaceae	30–50	12–18	(**30**)A
Puccinia	Pucciniaceae	30–50	12–15	14–22M
Dianthus	Caryophyllaceae	30–70	10–16	11–5M
Petroselinum	Umbelliferae	30–76	12–20	(**18**)M
Asphodelus	Liliaceae	30–110	18–30	14–19M
Cucumis	Cucurbitaceae	30–110	15–25	(**28**)M
Dianthus	Caryophyllaceae	31–75	18–36	14–13M
Musa	Musaceae	32–40	18–24	4–74M
Amaranthus	Amaranthaceae	32–64		14–15M
Hypoxylon	Xylariaceae	33–34		4–78M
Pelargonium	Geraniaceae	33–51	9–18	18–3M
Malva	Malvaceae	33–54	9–14	10–2A
Ricinus	Euphorbiaceae	34–47	10–13	(**17**)M
Daucus	Umbelliferae	34–51	10–22	(**14**)A
Papaver	Papaveraceae	34–51	10–12	(**17**)M
Ruta	Rutaceae	35–40	20	4–53M
Solanum	Solanaceae	35–119	3–21	(**10**)A
Pelvetia	Fucaceae	35–45	11–12	(**29**)M
Pyrus	Rosaceae	35–50	9–12	18–8M
Phytolacca	Phytolaccaceae	35–50	16–21	(**6**)
Apium	Umbelliferae	35–50	18	4–14M
Lycopersicum	Solanaceae	35–66	16–20	(**28**)A
Laminaria	Laminariaceae	35–70	16–25	(**30**)M
Allium	Liliaceae	35–60	10–15	4–71M
Linaria	Scrophulariaceae	35–60	12–20	(**5**)M
Phytolacca	Phytolaccaceae	35–100	15–18	4–26M
Magnolia	Magnoliaceae	35–100	18–22	4–48M
Gossypium	Malvaceae	36–40	14–16	4–11M
Gossypium	Malvaceae	36–50	18–22	(**28**)M
Arnica	Compositae	36–40	30	22–7M
Goniolimon	Plumbaginaceae	36–48	14–20	4–30M
Mulgedium	Compositae	36–51	24–30	14–14M
Citrus	Rutaceae	37–75	17–20	18–11M
Ricinus	Euphorbiaceae	39–47	10–13	(**17**)M
Scolopendrium	Polypodiaceae	40	15	10–25M
Hibiscus	Malvaceae	40	16–18	4–13M
Juncus	Juncaceae	40–45	14–16	11–16M
Ilex	Aquifoliaceae	40–50	8–10	22–3M
Ficus	Moraceae	40–50	10–16	14–17M
Lactuca	Compositae	40–50	15–20	4–18M
Nicotiana	Solanaceae	40–100	15–20	11–7M
Malva	Malvaceae	40–100	12–15	14–5M
Allium	Liliaceae	40–50	20–25	10–22M
Zea	Gramineae	40–50	18	4–61M
Calamagrostis	Gramineae	40–50	20–25	4–64M
Viola	Violaceae	40–60	10–17	16–1A
Vitis	Vitaceae	40–60	12–14	10–5A
Abies	Pinaceae	40–60	30–38	4–3A
Lycopersicum	Solanaceae	40–80	11–14	14–3A
Cucurbita	Cucurbitaceae	40–80	20–25	4–4M
Sorghum	Gramineae	40–85	12–16	18–15M

(1)	(2)	(3)	(4)	(5)
Viola	Violaceae	40–90	16	14–2M
Malva	Malvaceae	40–100	12–15	14–5M
Iris	Iridaceae	40–120	20–25	11–15M
Prunus	Rosaceae	41–62	14–15	18–9M
Grossularia	Saxifragaceae	42–50	8–12	22–4A
Allium	Liliaceae	42–48	10–16	4–69M
Dianthus	Caryophyllaceae	42–53	15–20	18–2M
Cucumis	Cucurbitaceae	44–62	11–15	18–12M
Phaseolus	Leguminosae	45	10–12	11–1M
Panax	Araliaceae	45–65	15–20	(**28**)A
Baptisia	Leguminosae	45	16	4–43M
Silene	Caryophyllaceae	45–95	22–38	(**4**)M
Ficus	Moraceae	46–70	12–14.5	18–4A
Nelumbium	Nymphaceae	47–65	10–15	11–2M
Hedera	Araliaceae	48–56	11–13	18–13M
Jatropha	Euphorbiaceae	50	12–13	4–5M
Ilex	Aquifoliaceae	50	12–13	4–5M
Pisum	Leguminosae	50	12–13	4–5M
Cassia	Leguminosae	50	15	4–57M
Pinus	Pinaceae	50	15	4–34M
Soil	——	50	16	18–6A
Silene	Caryophyllaceae	50	23	11–11M
Sagittaria	Alismaceae	50–60		4–4M
Brassica	Cruciferae	50–60	12–14	4–8M
Canna	Cannaceae	50–60	14–20	4–73M
Boucerosia	Asclepiadaceae	50–60	15	4–21M
Ammi	Umbelliferae	50–60	15–18	4–15M
Prunus	Rosaceae	50–60	17–20	22–5A
Ferula	Umbelliferae	40–65	9–10	(**25**)M
Calycanthus	Calycanthaceae	50–70	11–13	10–6M
Asparagus	Liliaceae	50–70	15	4–77M
Phytolacca	Phytolaccaceae	50–70	20–25	4–24M
Lactuca	Compositae	50–70	20–25	4–24M
Papaver	Papaveraceae	50–72	18–30	(**3**)M
Saponaria	Caryophyllaceae	50–80		4–28M
Nicotiana	Solanaceae	50–90	10–15	11–6M
Abutilon	Malvaceae	50–90	10–15	10–20M
Pyrus	Rosaceae	50–100	10–15	4–46M
Prunus	Rosaceae	52–64	13–18	18–5A
Papaver	Papaveraceae	52–80	14–20	10–3A
Heracleum	Umbelliferae	55	15	14–7M
Papaver	Papaveraceae	55–100	25–35	(**12**)M
Daucus	Umbelliferae	55–180	12–14	10–17M
Cucumis	Cucurbitaceae	55–110	15–25	14–9M
Camellia	Ternstroemiaceae	56–100	15–25	10–7M
Malva	Malvaceae	58	17	4–10M
Sparganium	Sparganiaceae	60	11–12	22–12M
Bark		60	18–20	4–37M
Crithmum	Umbelliferae	60	23	11–10M
Phaseolus	Leguminosae	60–62	15	14–1A
Cucurbita	Cucurbitaceae	60–68	8–9	10–1A
Asclepias	Asclepiadaceae	60–70	10	4–20M
Datura	Solanaceae	60–70	10	4–32M
Solanum	Solanaceae	60–70	10	4–32M
Citrus	Rutaceae	60–70	14–18	4–2A
Agave	Amaryllidaceae	60–70	14–17	22–10M
Bambusa	Gramineae	60–70	22	10–23M
Brassica	Cruciferae	60–80	14–18	4–2A
Hibiscus	Malvaceae	60–80	16–20	4–12M

(1)	(2)	(3)	(4)	(5)
Zea	Gramineae	60–80	20	4–63M
Dianthus	Caryophyllaceae	60–80	40	4–27M
Quercus	Fagaceae	64–85	15–17	10–1M
Palms	Palmaceae	65–70	30–35	10–6A
Avena	Gramineae	70	10–12	16–4M
Dahlia	Compositae	70	17	4–17M
Sonchus	Compositae	70	11	(**27**)A
Citrus	Rutaceae	60–75	15–20	16–2M
Trichosanthes	Cucurbitaceae	80–95	13–15	18–1A
Spinacia	Chenopodiaceae	80–120	12–14	16–2A
Cruciferae	Cruciferae	90–350	13–42	(**1**)A
Triticum	Gramineae	95–110	18–20	14–1A
Cucumis	Cucurbitaceae	100	14–20	22–1A
Lycopersicum	Solanaceae	100–120	20–22	4–54M
Solanum	Solanaceae	100–140	15–18	4–31M
Cynara	Compositae	100–140	19–20	10–11M
Dianthus	Caryophyllaceae	100–160	16–25	18–2A
Solanum	Solanaceae	104–184	14–18	(**22**)A
Allium	Liliaceae	105–320	12–24	(**16**)A
Solanum	Solanaceae	110–116		11–9M
Brassica	Cruciferae	115–240	20–25	14–3M
Brassica	Cruciferae	120–140	20–25	4–2A
Solanum	Solanaceae	120–296	12–20	(**22**)A
Carex	Cyperaceae	120–150		14–20M
Datura	Solanaceae	128–448	16–40	(**21**)A
Solanum	Solanaceae	145–370	16–18	(**28**)A
Allium	Liliaceae	150–180	15–20	4–70M
Nasturtium	Cruciferae	200–225	21–26	4–9M
Datura	Solanaceae	200–290	18–20	11–8M

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AGRICULTURAL EXPERIMENT STATION,
BOZEMAN, MONTANA

NOTES AND BRIEF ARTICLES

Dr. G. R. Bisby, Pathologist in the Manitoba Agricultural Experiment Station, Winnipeg, Canada, recently stopped at The New York Botanical Garden on his way to Europe where he will spend a year continuing his mycological studies in various European herbaria.

News of the death of Professor F. S. Earle at his home in Herradura, Cuba, on January 31, 1929, reached us in February. Professor Earle is well known to mycologists in every part of the world and has been Associate Editor of MYCOLOGIA from its inception. A more detailed account will appear in some later issue of MYCOLOGIA.

Doctor B. O. Dodge, Pathologist at The New York Botanical Garden, spent January 24th and 25th at Cornell University in conference with members of the staff and graduate students in the Department of Plant Pathology and Genetics. While there he lectured on "Sex in the Fungi and the Production of Fertile Interspecific Hybrids."

A NEW MUSHROOM BOOK

The series of G. P. Putnam's Nature Field Books has recently been augmented by an excellent little volume entitled "Common Gilled Mushrooms," by Dr. W. S. Thomas. American literature has in the past been noticeably lacking in books of this type, and especially so when compared with the output of such works in Europe. Dr. Thomas's book fills, therefore, a very definite want, and will be warmly welcomed by all interested in this field of inquiry. To the advanced student, the fine color paintings from the work of Miss Eaton, here brought together for the first time, will prove extremely useful, including as it does 16 plates representing 96 species of mushrooms. A few half tones and some pen and ink drawings are also included. The work on

all of these is of a very high quality and constitutes no inconsiderable part of the value of the volume. To the mycophagist and the mycologist alike the very complete descriptions of 128 species of gilled fungi, with additional notes and comments, often from the writings of Peck, Atkinson, and Kauffman, will go a long way towards settling the question of the identity of the common species of our woods and fields. Probably no one knows, even approximately, how many species of mushrooms any limited region contains, but certainly 128 species is a goodly number, and all of these are to be found in at least our eastern flora. For example, descriptions and illustrations are given of 10 species of *Clitocybe*, 6 species of *Collybia*, and 3 species of *Coprinus;* and when one has learned to know these common species he is on the way to a fairly comprehensive acquaintanceship with these genera. No volume in the nature of a field manual, particularly for the amateur, could include all the species in any region. To attempt such a task would defeat the purposes of such a manual. The author has chosen his species wisely and presented them in a thorough and a pleasing manner.

The novel feature of this volume is the author's attempt to present a scheme whereby one may determine the identity of a mushroom with the least possible effort. Approximately one-third of this volume of some 300 pages is devoted to this scheme. The fear is that the very magnitude and the *apparent* complexity of this part of the work will deter the beginner from attempting to use it. When one learns the scheme, however, it is really not complex, and the more one will work with it the easier it will become. Perhaps the author has not sufficiently emphasized, in his explanation of this synopsis, the best course to pursue. He is so familiar with the scheme from years of association with it that it probably does not occur to him that there can be any element of complexity or doubt as to how to proceed. This statement is made in spite of the three examples given by the author to illustrate the process. If the reviewer understands the way this synopsis is supposed to work, the first question one must ask himself is: "What is the outstanding feature of the plants at hand?" It may be the pure white color of the entire plant, the strikingly violaceous color of gills or pileus, the lack of a stem,

the place of growth, etc. All of the species that possess this character are grouped into a synoptic outline in such a way that, by the aid of a few other characters, it will often be possible to identify the plant with very little effort. However, everything depends on selecting the outstanding character, or any one of several in some cases. Many species, however, do not possess what, to the amateur, might be considered outstanding characters; in other words, many species "all look alike" to the untrained eye. It is these that will be troublesome to identify. This type of key does have the advantage that in case of species with more than one prominent character one can attempt its identification by more than one route, and if the result is the same in all cases the identity is assured. Perhaps it is unfortunate, however, that a key of the usual sort was not included for the benefit of the more advanced student, at least. However, four pages of line drawings representing typical specimens of all the genera will be found helpful in this respect.

A chapter on "Mushrooms as Food" reproduces Peck's article in the 48th Report of the New York State Museum, and two additional short chapters are devoted to recipes for cooking mushrooms.

The names used are in all cases the old established ones by which they have been so long known in this country. This is a commendable feature of the book. The press work is unusually well done, and the pages are practically if not entirely free from typographical errors. Finally, the book is very attractively bound and will be a distinct addition to any book shelf. Every one interested in gill fungi should have a copy. There is no question but that it will be the most popular mushroom book yet issued in this country, and Dr. Thomas and the Putnam Company should have the best thanks of American mycologists and mycophagists for making it available in such excellent form.

L. O. OVERHOLTS.

A NEW RUST HANDBOOK

Handbook of the North American Uredinales including Citations and Synonymy. By ELAM BARTHOLOMEW. 1928.

In this Handbook of 193 pages the author presents a catalog of the species of the North American Uredinales, with synonomy

and citations. According to a summary in the "Foreword" there are 1,240 species [1] and 3,505 synonyms. The area included embraces continental North America, Greenland, and the West Indies. The book was printed in Stockton, Kansas, the home of the author. The arrangement and the choice of type is good.

This handbook is just what it purports to be, *i.e.*, a list of the species of rusts. There are no notes and no references to hosts. The family and generic arrangement is largely based on Arthur's treatment in Volume 7 of the North American Flora with the notable exceptions that *Puccinia* replaces *Dicaeoma*, *Allodus*, *Bullaria*, and *Micropuccinia*, and *Uromyces* replaces *Nigredo*, *Pucciniola*, *Klebahnia*, and *Teleutospora*. The arrangement of species under a genus is alphabetical. After every species which is included in the North American Flora is cited the number of the page or pages where the species is described or referred to in the Flora. This handbook, therefore, serves as an index to Volume 7 of the Flora.

Bartholomew states that "several new combinations in authorship have been made where the shifting in nomenclature seems to warrant them." One cannot refrain from expressing a regret that these new combinations are not specifically indicated. As it is, there is nothing to indicate a transfer except that the author has placed his name after the parentheses and no citation follows. To determine just what changes have been made in this work would require some very close observations. This is particularly true here because the citation follows not on the same line with the specific name but on the next line. This increases very materially the difficulty. The second line must always be examined to determine whether a citation is or is not given.

In these days of shifting ideas as to nomenclature it is always a matter of interest to examine a catalog of names to discover what system, if any, is being followed. Some unusual situations are always likely to be found. In this work the author evidently has no objections to specific names because they are founded on aecial stages. For example he accepts *Puccinia Asterum* as the

[1] According to my count, Arthur describes 1,218 species in Vol. 7 of the North American Flora.

name for the *Carex-Aster* rust and *Puccinia urticata* for the *Carex-Urtica* rust. Many other examples could be cited. An interesting case is where a new combination *Puccinia Sommerfeldtii* (Johans.) Barth. is made, based on *Aecidium Sommerfeldtii* Johans. On the other hand *Puccinia graminis* Persoon is maintained although on the basis of the three names just referred to the name would be *Puccinia poculiformis* (Jacq.) Wettst., based on the aecial stage *Lycoperdon poculiforme* Jacq., which has priority over the specific name *graminis*. This is apparently a situation where priority is deliberately disregarded and a later name is conserved. One cannot disagree with the evident motive for such a procedure, since a feeling of fitness may make a stronger appeal than the rigid application of a rule. It does seem reasonable, however, that a definite note of explanation of procedure should be offered, for otherwise the use that is made of the names that the past has bequeathed to us is not clear. In looking down the list of synonyms it is surely right to expect a uniform treatment unless attention is clearly called to the exception. The reviewer wishes to point out that these remarks are not to be regarded as a criticism of this Handbook alone, but rather as a commentary on a general condition that obtains in mycological nomenclature, to which attention must be given, if we are ever to come to an acceptable and workable system.

There is one feature, however, for which the author of this Handbook must be adversely criticized. It often happens, as everyone knows, that the oldest specific name cannot be used because it is preoccupied in the genus to which it is being referred. In that case a later name is taken up or, if none exists, a new one must be proposed. Always the reason for not taking up a name must be distinctly given or otherwise an apparently acceptable name is disregarded without cause. A single instance will illustrate the point. On p. 160 *Puccinia Sarcobati* (Peck) Bethel, a combination made in 1921, is accepted as a valid name founded on *Aecidium Sarcobati* Peck, 1881. The first synonym listed is *Aecidium biforme* Peck, 1875. If this were followed with the statement "Not *Puccinia biformis* Lagerh. 1896" the matter would be clear. As it stands, one is uncertain why the prior name is rejected. Such instances are altogether too numerous

and throw too much burden on the user to comprehend just what the situation is.

This is the first attempt to bring together under one cover a complete list of the North American rusts and mycologists both at home and abroad are under obligations to the author for this work.—FRANK D. KERN.

PROPOSED AMENDMENTS TO THE INTERNATIONAL RULES OF NOMENCLATURE

1. Art. 19. Amend to read:

   Botanical nomenclature begins for all groups of plants (recent and fossil) at 1753 (Linnaeus, *Species Plantarum*, ed. 1).

   It is agreed to associate genera, the names of which appear in Linnaeus's *Species Plantarum*, ed. 1, with the descriptions given of them in the *Genera Plantarum*, ed. 5 (1754).

2. Art. 49 bis. Omit *in toto*.

3. Add the following to the list of Nomina Conservanda:

Fam.	*Nom. conserv.*	*Nom. rejic.*	*Typus*
Pucciniaceae	*Uromyces* (Link, Ges. nat. Freunde Berlin Mag. VII (1815) p. 28) Unger, Exanth. Pfl. (1833) p. 277.	*Caeomurus* (Link Ges. Nat. Freunde Berlin Mag. III (1809) p. 7) S. F. Gray Nat. Arr. Brit. Pl. I (1821) p. 541. *Pucciniola* Marchand, Bijdr. Nat. Wet. IV (1829) p. 47.	*Uromyces appendiculatus* (Link) Unger, on *Phaseolus vulgaris*.

REMARKS ON THE AMENDMENTS

1. The effect of the amendment is to make the Rules apply to all plants alike. Any date later than 1753 can affect very few

names in any one group of plants, and such names can be treated in the list of nomina conservanda.

2. This article is founded upon a misunderstanding of the practical difficulties in the way of recognizing the "perfect" and "imperfect" states in many instances. It also fails to recognize the relative taxonomic importance of names when applied to the different states. The old idea that species and genera can not be distinguished by the urediniospores is not only untrue, but as a matter of fact they are the chief, and often the only means for such distinctions in some groups, *e.g.*, in the genera *Uredinopsis*, *Hyalopsora* and *Milesia*, and in species among the grass and sedge rusts (see key to same in N. Am. Flora **7**: 269–274). The application of the rule is not likely to meet with approval from those who are best informed. The result aimed at can better be attained by means of nomina conservanda.

3. *Uromyces* is a well known generic name, and is as acceptable in every way as the less known earlier names.

TO BOTANISTS INTERESTED IN THE TAXONOMY OF THE LOWER PLANTS

The International Rules of Nomenclature adopted at Vienna in 1905 applied only to phanerogams and ferns. At the Brussels Congress in 1910 a certain amount of recognition was accorded to the lower plants. The Ithaca Congress in 1926 strengthened the committees to look after and report on nomenclature at the Congress to be held in Cambridge, England, August, 1930. The writer attended these Congresses as a member of the committee on cryptogamic nomenclature, and intends to be present at the next Congress.

Firmly believing that the naming of plants of all gradations should be guided by essentially the same rules, I propose to present 3 motions to amend the Rules, as shown above. I am distributing these propositions as widely as possible to ascertain how much support they are likely to receive from other taxonomists. As these motions must be presented in printed form to the chairman, Dr. John Briquet, Geneva, Switzerland, by

March 31, 1929, I will be pleased to learn as early as possible, whether you are willing to support any one or all of the motions by your signature. If you prefer a modified form, please so indicate.

The matter presented above was sent out in mimeograph form early in March to a large number of botanists, and many replies have been returned. Since it was written, word has been received that the time for reporting to Dr. Briquet has been extended to September. The liberal extension of time will enable European botanists and many others to reply, who may have thought the limited time made it unnecessary.

The Rules as they now stand give the priority date for mosses, rusts, smuts and gasteromycetes as 1801, and for other fungi 1821–32, for desmids 1848, nostocs 1886–93, oedogoniums 1900, leaving bacteria, flagellates, diatoms, and some other groups undecided. These arbitrary exceptions to 1753 as an acceptable date for beginning priority in the majority of plants are open to controversy. The writer will be pleased to learn the opinion of botanists interested in the several classes of plants, and of others as well.

As voting in the Congress is not confined to specified groups, the writer would like to ascertain not only how many favor the proposed changes wholly or in part, but what opposition to their presentation is likely to develop.

J. C. ARTHUR, PURDUE UNIVERSITY,
LAFAYETTE, INDIANA.

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Vol. 32, part 1, 1918; part 2, 1921. Rubiaceae (pars).

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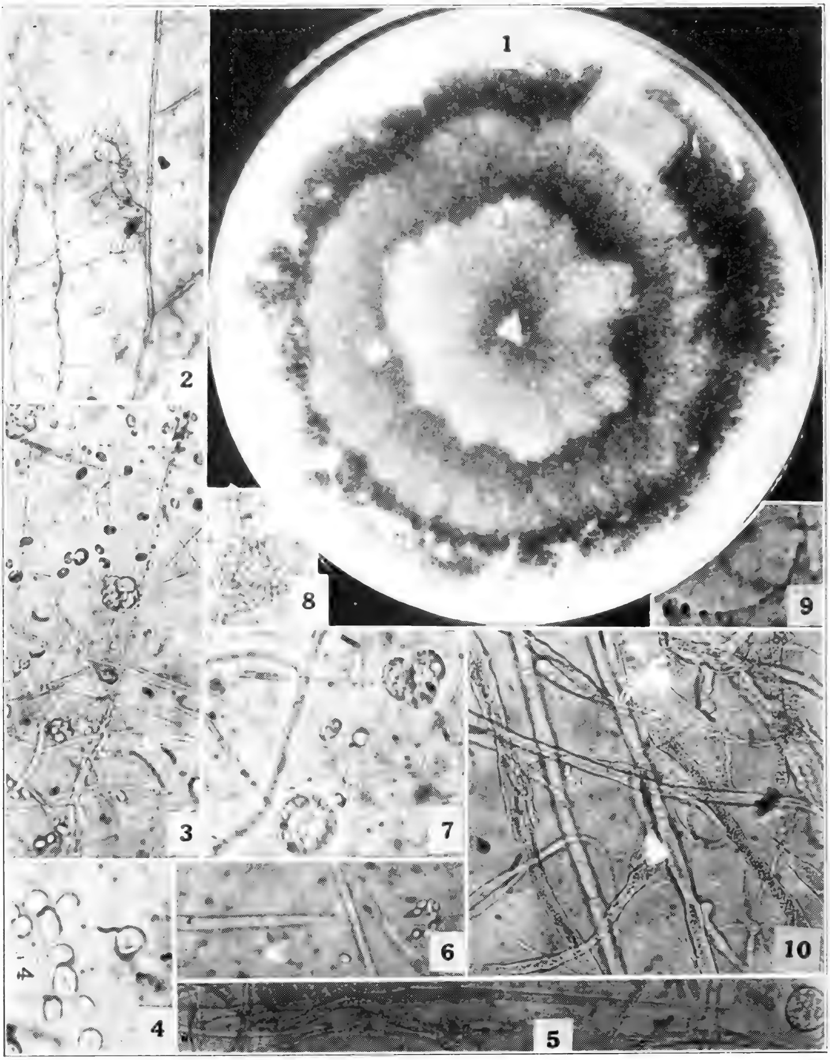

MORTIERELLA ELASSON

MYCOLOGIA

Vol. XXI JULY–AUGUST, 1929 No. 4

A NEW SPECIES OF MORTIERELLA

C. P. Sideris and G. E. Paxton

(With Plate 12)

During the isolation of various parasitic as well as saprophytic fungi from diseased roots of pineapple plants a Phycomycete was obtained that refused to sporulate for a very long time. This organism finally sporulated while growing on a corn-meal agar media prepared in our laboratory.

The corn-meal decoction was obtained by partial hydrolysis of 50 grams of corn-meal with 10 cc. $1/N$ HCl in 500 cc. of water for 2 hours, at 80° C. The acid was neutralized at the end of this period by a corresponding volume of $1/N$ NaOH, and then 1 gram of trypsin, obtained from the Digestive Ferments Co., was added for further hydrolysis. The mixture was allowed to stand for 48 hours at 40° C. At the end of this period the fluid portion was removed by filtration through cotton and qualitative filter paper and then made to 2,000 cc. with additional tap water. The amount of agar agar added was 2 per cent.

This organism, as well as others that we have in our laboratory, has been found to sporulate more readily on these media than on any of the other standard media used so far in these studies. It has produced sporangia with perfect spores but no zygospores. Sporangia, but without perfect spores, were also produced by the same organism in a number of other media.

The organism differs considerably from various other *Mortierella* species in that its sporangiophores are considerably smaller than those of any of the other known species (Fig. 1). The spo-

[Mycologia for May–June (**21**: 113–173) was issued May 1, 1929]

rangiophores emerge from non-differentiated hyphae and stand always above the media. They may or may not have rhizoids. Gemmae have also been observed very often on malt peptone agar, but not as often on corn-meal agar.

The sporangial membrane is very fragile, which fact may account for the rare occurrence of non-bursted ripe sporangia. The slightest amount of friction is capable of causing the mature sporangia to burst and set their spores free in the surrounding media. The spores vary in shape from spherical to ovoid and measure in width from 2 to 3 μ and in length from 4 to 7 μ. The mycelium varies considerably in thickness, measuring on the average about 6 μ, but in extreme cases it has been found as thick as 10 μ and as thin as 1 μ.

Mortierella elasson nov. sp.

Sporangiophores long, from 200 to 500 μ, wide at the base, from 5 to 10 μ, and at the tip from 3 to 6 μ, not branched, non-septate, colorless and having from none to few rhizoids. Sporangia from 10 to 24 μ in diameter, spherical or slightly ellipsoid, colorless, varying considerably in the number of their spores and very fragile during maturity. Spores commonly oval, but sometimes spherical or tetrakaidecahedric, 3 to 6 μ wide and 5 to 10 μ long and in rare cases few may be twice or three times as large. Zygospores never observed. It grows saprophytically on dead pineapple roots. It was obtained from roots of pineapples grown on the islands of Oahu and Maui, Territory of Hawaii.

The specific name *elasson* of the organism is taken from the Greek word ἐλάσσων = minor, owing to the small size of its sporangiophores.

A comparative study of this and other species indicates that the size of the sporangiophores, sporangia and spores is considerably smaller than that of any of the species described so far. The species *M. simplex* Van Tieghem & Le Monnier, *M. Rostafinskii* Brefeld, and *M. strangulata* Van Tieghem with which this organism is more closely related than any others have sporangiophores measuring in length between 600 and 1,000 μ, in width at the base between 50 and 100 μ and at the tip between 15 and 30 μ. The sporangia in these same species measure between 50 and 120 μ in diameter, and the sporangiospores

between 5 and 10 μ. There cannot be any doubt whatsoever but that this organism constitutes a new species.

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EXPLANATION OF PLATE 12

Fig. 1. Colony on corn-meal agar 10 days old; 2. Hyphae. ($\times$ 150); 3. Sporangium and spores. ($\times$ 300); 4. Spores. ($\times$ 600); 5. Sporangiophore with sporangium intact. ($\times$ 300); 6. Sporangiophore with collapsed sporangium. ($\times$ 300); 7. Sporangia. ($\times$ 600); 8. Spores. ($\times$ 300); 9. Germinating spore. ($\times$ 600); 10. Hyphae. ($\times$ 300.)

STUDIES IN TROPICAL ASCOMYCETES—VI. PHYLLACHORA SIMABAE CEDRONIS

FRED J. SEAVER

(WITH 2 TEXT FIGURES)

In the fifth installment of this series of articles the writer published a supposedly new species of *Phyllachora* from South America on an unnamed host. Shortly after this article appeared

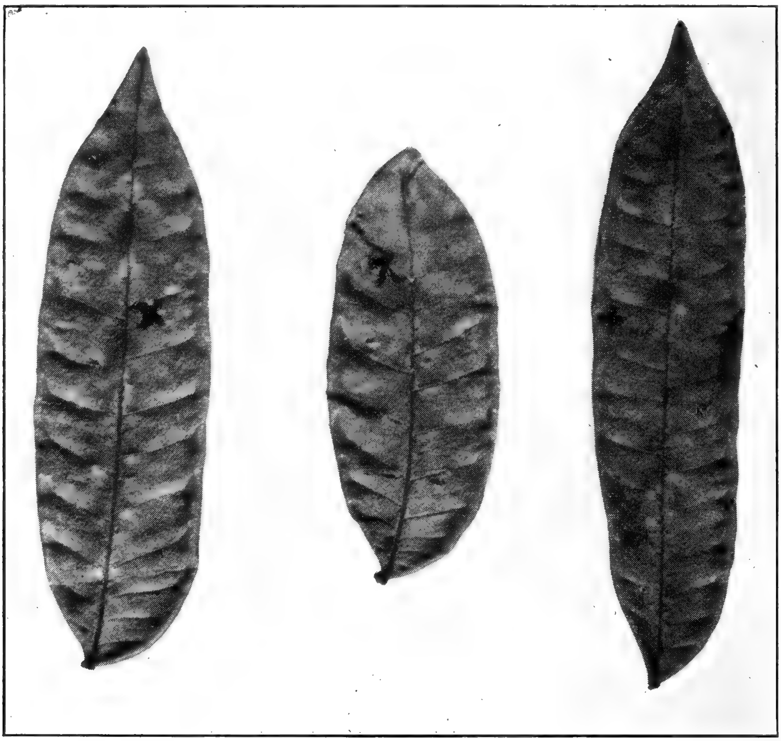


FIG. 1. *Phyllachora Simabae Cedronis* on small leaves on *Simaba Cedron* Pl. from Costa Rica. Taken from the phanerogamic collection of The New York Botanical Garden. A. Tonduz *9948*.

a letter was received from Dr. H. Sydow of Germany, stating that our *Phyllachora Pennellii* was the same as the Costa Rican *Phyllachora Simabae Cedronis* P. Henn.

Following this suggestion the writer went through the phanerogamic collection of The New York Botanical Garden looking over herbarium specimens of this host. As a result of this search a specimen of *Phyllachora* resembling *Phyllachora Pennellii* was obtained on leaves collected in Costa Rica. This specimen although resembling our species differed slightly in general appearance and the writer was still unconvinced that *Phyllachora Pennellii* and *Phyllachora Simabae Cedronis* were the same thing.

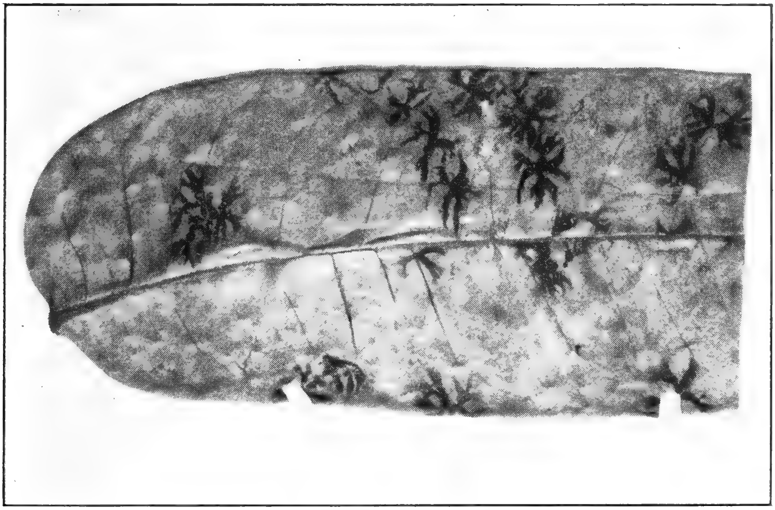


FIG. 2. Photograph of the type of *Phyllachora Simabae Cedronis* loaned by H. Sydow from Germany. Cf. Mycologia **20**: *pl. 26, f. 1.*

At the request of the writer, Dr. H. Sydow later loaned to us the type specimen of P. Hennings' species, a photograph of which is here reproduced. This proves conclusively that the two are identical. Had we been able to name the host on which our species occurred this oversight would doubtless not have occurred but inasmuch as Dr. Pennell did not know the host it was impossible to use this as a clue in running down the species. As often happens the fungus in this case has enabled us to identify the host. The synonymy of the species would then be as follows:

PHYLLACHORA SIMABAE CEDRONIS P. Henn. Hedwigia **43**: 147. 1904.

Phyllachora Pennellii Seaver, Mycologia **20**: 222. 1928.

THE NEW YORK BOTANICAL GARDEN

NOTES ON THE PARASITIC FUNGI OF ILLINOIS—IV

L. R. Tehon and G. L. Stout

(With Plate 13)

Specimens obtained while prosecuting the plant disease survey of Illinois, which has been under way as one of the activities of the Illinois State Natural History Survey since 1922, continue to supply new and interesting examples of parasitic fungi. This paper, in common with our previous "Notes," is devoted chiefly to the description of new non-economic forms; but we have appended an additional list of species, either not hitherto known to occur in Illinois or with new localities and notes on distribution.

Type specimens upon which our novelties are based are denoted by their accession numbers in the Mycological Collection of the Natural History Survey. When the type material is abundant, a deposit is being made also with the New York Botanical Garden. The names of wild hosts are those given in the 7th edition of Gray's Manual.

We are constrained, in our treatment of the Ascomycetes and pycnidial forms, to make a limited use of the newer European classifications, for which the discussion of the individual cases will show the convenience.

Stigmatophragmia Tehon & Stout, n. gen.

Genus of the Hemisphaeriales, family Stigmateaceae. Perithecia subcuticular, hemispheric, membranous to carbonous. Perithecial cover pseudoparenchymatic. Paraphyses present. Ascospores hyaline, oblong to fusoid, several septate.

This genus, based on the species subsequently described, is very certainly allied with the Hemisphaeriales. Most of its characters are those of the Hemisphaeriaceae; but its perithecia, which lie within the host, appear to have developed beneath the cuticular membrane, and this character alone, to which much weight is given by Sydow, throws it definitely out of this family

and unites it at once with the Stigmateaceae, while the pseudoparenchymatic perithecial cover, which very evidently develops from a truly radiate beginning, makes it distinctive among the genera of this family. It appears to parallel *Stigmatodothis* in most respects but has true paraphyses. Its position may be outlined as follows:

Perithecial membrane distinctly radiate...*Stigmatea, Stigmatodothis,* etc.
Perithecial membrane pseudoparenchymatic.
  Paraphyses present.
    Spore 2-celled, brown; ascoma setate......................*Coleroa*
    Spore several-celled, hyaline; ascoma smooth.......*Stigmatophragmia*
  Paraphyses absent...*Aphysa*

Stigmatophragmia sassafrasicola Tehon & Stout, n. sp.

Foliicolous. Spots diaphyllous, circular or somewhat angular, 3–5 mm. in diameter, tan to brown epiphyllously, never cinereous, not friable, definitely limited by a distinct, very fine, unraised, purplish margin; characters similar hypophyllously but obscured by leaf bloom. Thyrothecia few, widely scattered, hypophyllous only, round, 200–225 μ in diameter, subcuticular, opening by a somewhat umbonate, carbonaceous, round ostiole 18–34 μ wide; thyrothecial membrane pseudoparenchymatic, non-radiate. Paraphyses filiform, unbranched, abundant, equalling or slightly exceeding the height of the asci. Asci cylindric, thin walled, abruptly rounded at the apex and the base, short-stiped, 8-spored, 65–80 $\times$ 10–15 μ. Spores hyaline, 3-septate, cylindric with tapered end-cells, or spindle-shaped, straight or slightly flexed, outline constricted at the septa, 14–17 $\times$ 3–4 μ; individual cells of equal length. PLATE 13, FIG. 1.

On *Sassafras variifolium.*

Seymour, Champaign County, October 15, 1925. Acc. No. *20103* (type).

On the same leaves are spots bearing the acervuli of the very common *Gloeosporium affinis;* but there seems to be no connection between the two fungi. This and the type of the new genus *Pseudodictya* described on a later page were taken from the same tree.

Melanospora interna Tehon & Stout, n. sp.

Perithecia developed in the pith cavity but not imbedded in the pith, very abundant, scattered, discrete, with a few hyaline mycelial hairs, translucent, golden-yellow, globose, rostrate,

150–300 μ in diameter; cavity 125–270 μ in diameter; rostrum 50–135 μ high, cylindrical, 40–55 μ wide, without an apical fringe of hairs. Asci saccate to very broadly clavate, evanescent, disappearing as the spores mature, 40–55 × 17–21 μ. Spores 8 per ascus, biseriate as a rule, broadly spindle-shaped, continuous, chocolate brown but with a small, light, almost hyaline region at each end, whence come the germ-tubes, 19.5–22 μ long, 8.5–11 μ broad, the walls marked with coarse, irregular reticulations. PLATE 13, FIG. 2.

On *Lycopersicon esculentum*.

Mound City, Pulaski County, November 13, 1927. Acc. No. *20939* (type).

This form is amply distinct from the species hitherto described. Between it and *M. Solani* Zukal there are few points of agreement, for the larger perithecia, the very long and comparatively wide rostrum, the narrower and longer asci, and the very much larger spores separate it completely. The habit, also, may be significant, as the plant from which it was taken appeared to be suffering from a type of root rot, the cause of which may have been this fungus, whose perithecia lined the cavity in the lower stem where the pith had disappeared.

Taxonomic characters within this genus are more striking than is usual in distinctive groups. The brilliant yellow perithecium, the usually very evident rostrum, the remarkable shape of the spores, and the typically evanescent asci serve to ally the forms now known. Among the species, *M. carpophila* Zukal is segregated by the possession of paraphyses; *M. antarctica* Speg. and *M. Marchaliana* Bomm. are at once allied to each other and separated from others by their long, cylindrical asci, in which the spores are disposed uniseriately; *M. ornata* Zukal and our *M. interna* possess spores with reticulate walls; and the remaining species, over 30 in number, though closely similar, appear readily distinguishable by means of such characters as spore-size, ascus measurements, and the like.

Metasphaeria Asparagi Tehon & Stout, n. sp.

Caulicolous. Maculicole rather than cankerous, the spots taking the form of much elongated, rather wide, gray lesions, from which the loosened cuticle falls away and exposes the perithecia, which are seated on the woody tissue beneath. Perithecia

numerous, scattered, subglobose, membranous, dark brown or carbonaceous, 220–375 μ in diameter, opening by means of a papillate, usually carbonized ostiole 6–14 μ in diameter. Asci long-clavate, verging to cylindrical, straight or (when from the sides of the perithecia) curved, short-stalked, double-walled, 75–130 × 11–16 μ. The inner wall of the ascus, with its content of spores, often slips out of the external sheath. Paraphyses hyaline, filamentous, 1–1.5 μ wide, equaling or exceeding the height of the asci. Ascospores hyaline, 3–5- but usually 4-septate, oblong, 17–25 × 5–6.5 μ, constricted at the septa, the second cell from the top (and sometimes adjacent cells) nearly spherical. PLATE 13, FIG. 3.

On *Asparagus officinalis*.

Anna, Union County, November 11, 1926. Acc. No. *19944* (type).

With this fungus there is found in some lesions a *Phoma*, recorded on another page as *P. asparagina*, which may be a pycnidial form—at least, there is no evidence of distinct mycelia.

Metasphaeria sassafrasicola Tehon & Stout, n. sp.

Foliicolous. Spots diaphyllous, subcircular, tan, with a narrow, dark-brown border, 3–7 mm. in diameter, occasionally confluent. Perithecia scattered, not gregarious, membranous, developed in and occupying the mesophyll, spherical, 75–100 μ in diameter; ostiole erumpent epiphyllously, papillate, somewhat carbonized, its opening 15 to 20 μ in diameter. Asci few, 6–10 per perithecium, oblong, with a short, blunt foot, uniformly 44–45 × 12–13 μ. Paraphyses few, filiform, equaling the asci in height. Ascospores 8 per ascus, 3-septate, hyaline, arranged either irregularly or in 2 bundles of 4 each, 16–18 × 2.2–2.4 μ; the pre-apical cell round. PLATE 13, FIG. 6.

On *Sassafras variifolium*.

Seymour, Champaign County, October 15, 1925. Acc. No. *20103* (type).

Pleospora Oleraceae Tehon & Stout, n. sp.

Foliicolous. Spots chiefly circular, sometimes oval, 0.75–5 mm. in diameter, white, with a distinctly raised border, the interior collapsed, papery, and translucent. Perithecia innate, membranous, spherical, 65–100 μ in diameter, erumpent epiphyllously. Ostiole circular, only slightly raised, 20–40 μ in diameter. Paraphyses filiform, equaling the asci. Asci few,

thin-walled, short-stalked, asymmetrically oval, 45–48 × 18–21 μ. Spores crowded, 8 per ascus, smoky to distinctly olivaceous, oval, thick-walled, with 3 or 4 horizontal septa, medial cells variously divided longitudinally, 22–28 × 8.8–11.0 μ, never more than very slightly constricted. PLATE 13, FIG. 4.

On *Brassica oleracea.*

West Vienna, Johnson County, July 7, 1926. Acc. No. *19358* (type).

This is quite distinct from *P. herbarum* var. *Brassicae* (Lasch) Sacc., in which the perithecia are three or more times as wide, the asci nearly three times as long, and the spores half again as wide. It falls in Saccardo's section Eu-Pleospora.

Phyllosticta Rugelii Tehon & Stout, n. sp.

Foliicolous. Spots diaphyllous, irregularly circular, dark-brown and concolorous above and below, faintly marked concentrically by the collapse of diseased tissue, 2–10 mm. in diameter. Pycnidia borne in circular to oval, unbordered, cinereous, deciduous areas 1–3 mm. in diameter, abundant, scattered, wholly membranous, translucent, spherical to slightly applanate, 35–65 μ in diameter, developed in and occupying the collapsed mesophyll, opening only through the epiphyll by means of a long-papillate ostiole 4–8 μ wide. Spores hyaline, continuous, chiefly elliptic but with oval and asymmetrically allantoid variants, 6.5–8.5 × 2–3 μ.

On *Plantago Rugelii.*

Lawrenceville, Lawrence County, June 27, 1926. Acc. No. *19477* (type).

This distinctive species forms the fourth of a group now known *Plantago*, among which it lies at the lower extreme of variation with respect to the size of the pycnidium. Upon this character alone, it can be separated very certainly from the others. In length of spore it shows more variation that *P. plantaginicola* Tehon & Dan., and lies midway between *P. plantaginella* Sacc. and *P. Plantaginis* Sacc. In spore width it coincides with the two last named, and approaches in its wider variates the narrower variates of the one first named.

Phyllosticta podophyllina Tehon & Stout, n. sp.

Foliicolous. Spots diaphyllous, circular, ½–4 mm. in diameter, tan, with a narrow, distinctly raised, concolorous margin;

the base of the spot collapsed and disorganized but not deciduous. Pycnidia abundant, scattered, spherical, developed in and occupying the mesophyll, visible amphiphyllously but opening epiphyllously, only the upper half of the pycnidium becoming erumpent, 70–95 μ in diameter. Ostiole circular, not papillate, 10–12 μ in diameter. Spores continuous, hyaline, oblong, with abruptly rounded ends, 6–8.5 × 2–2.5 μ.

On *Podophyllum peltatum*.

Columbia, Monroe County, June 24, 1926. Acc. No. *19480* (type).

The distinctive character of this species, as compared with *P. Podophylli* (M. A. Curt.) Wint., which we have collected and examined many times in Illinois, is as apparent when it is seen in the field as when it is dissected beneath the microscope. Microscopically, its pycnidia are smaller, and the spores are very characteristic, there being no possibility of confusing their distinctly oblong outline with the subcircular outline of the spores of the older species.

Phyllosticta allegheniensis Tehon & Stout, n. sp.

Foliicolous. Maculae diaphyllous, circular, 1–4 mm. wide, with a dark, purple-tinted, unraised margin about ½ mm. wide, tan to cinereous, similarly colored above and below. Pycnidia developed in the mesophyll, immersed, few, scattered, opening either upward or downward by a papillate ostiole, immersed portion brown and membranous, erumpent portion dark brown or carbonous, round or oval in outline, flask-shaped, and often applanate at the base, 90–130 μ in diameter; ostiole round to oval, 14–30 μ in diameter. Spores hyaline, oval, continuous, 2–2.5 × 4–4.5 μ.

On *Rubus allegheniensis*.

Nashville, Washington County, July 29, 1926. Acc. No. *20940* (type).

This seems to be different from other species noted on *Rubus*. From the two known American forms, it is distinguished as follows:

Spores minute, 5 μ or less long.
    Spores rod-like, 1–1.5 × 4.5–5 μ. . . . . *P. Dearnessii*
    Spores oval, 2–2.5 × 4–4.5 μ. . . . . *P. allegheniensis*
Spores larger, 5–7 μ long. . . . . *P. variabilis*

Phyllosticta subeffusa (Ellis & Ev.) Tehon & Stout, comb. nov., descr. emend.

Synonym: *Phyllosticta Smilacis* Ellis & Martin var. *subeffusa* Ellis & Ev. in Ellis & Everhart's North American Phyllostictas, p. 72, 1900.

Foliicolous. Spots very extensive, involving large areas of, or very often the entire, leaf, most often appearing marginal but in reality arising from a laminar infection, arid and of a dead gray closely simulating natural death; borders indefinite, usually brown- to red-tinted and shading into the natural green of the leaf. Pycnidia abundant, scattered, 85–105 μ in diameter, membranous, becoming subcarbonous at length, developed in and occupying the mesophyll, spherical to applanate, never erumpent but opening toward either side by a slightly papillate, irregular ostiole sometimes 40 μ wide. Spores hyaline to very dilute green, continuous, rather constantly elliptical in outline, 7.5–11 × 2.2–4 μ.

On *Smilax* sp. (West Va., Nuttall) Ellis & Ev. North American Fungi, No. *3252*.

Also on *Smilax hispida*.

Knoxville, Knox County, August 26, 1926. Acc. No. *19444*.

The writers have no hesitancy in making the above change in the nomenclature of this rare and interesting fungus. During the past 6 years we have seen, collected, and examined critically many specimens of *P. Smilacis*, without encountering anything that could be classed as the variety *subeffusa*. The striking character of the variety, as exhibited in the North American Fungi specimens, leaves little doubt of the type of infection to be found; but it required five years of searching for us to secure it in Illinois. A single vine, climbing over a small tree, bore a number of leaves with the characteristic spots, and subsequent examination proved them to be typical of the variety. Distinction may be found between the two forms not merely in the form and texture of the host lesions but also quite definitely in the fungi themselves:

Species	Pycnidial diameter	Spores		
		Length	Width	Shape
P. Smilacis	110–150 μ	12–15 μ	3.5–4 μ	Oblong-fusoid
P. effusa	85–105 μ	7–11 μ	2.2–4 μ	Elliptical

Phoma asparagina Tehon & Stout, n. sp.

Caulicolous. Maculicolous rather than cankerous, the spots at first showing as long-elliptic, slightly sunken, gray lesions, later becoming confluent and producing extensive gray patches from which the cuticle falls, often also with a reddish-brown to purple margin. Pycnidia abundant, scattered, located in the epidermis and partly exposed by the falling of the cuticle, globose or applanate, brown, membranous, 50–150 μ in diameter; ostiole papillate, dark and often carbonized, 10–30 μ in diameter. Spores continuous, hyaline, oblong-elliptic, 3.5–6 $\times$ 1–2 μ.

On *Asparagus officinalis.*

Anna, Union County, November 11, 1926. Acc. No. *19943* (type).

This and an ascomycete, listed on a previous page as *Metasphaeria Asparagi,* occur on the same spots and may be related conidial and ascigerous forms.

From the two previously described species of *Phoma* attacking asparagus, one European and the other American, our Illinois species is separated as follows:

Spores blunt; pycnidia small (150 μ in diameter).
- Spores 7–8 $\times$ 3 μ .... *P. Asparagi*
- Spores 3–6 $\times$ 1–2 μ .... *P. asparagina*

Spores acute; pycnidia ½ mm. in diameter .... *P. media*

Macrophoma Smilacinae Tehon & Stout, n. sp.

Foliicolous. Spots circular to ellipsoid, about equally apparent on both sides of the leaf, 4–6 mm. long, sometimes confluent to form larger irregular lesions; their margins narrow, very definite, reddish-brown; their centers grayish-white and papery. Pycnidia scarce or many per spot and sometimes forming a circle near the periphery, macroscopically black, microscopically dark brown, membranous, of a meandering, plectenchymous structure, epiphyllous, flattened-globose, 100–225 μ in diameter; ostiole rounded, hardly papillate, but at least surrounded by a zone of darkened, thickened tissue, 12–22 μ across. Spores 1-celled, greenish to hyaline, irregularly narrow-ellipsoid, 11–22 $\times$ 3.5–6 μ, produced at the tips of hyaline sporophores.

On *Smilacina stellata.*

Marlow, Jefferson County, September 7, 1926. Acc. No. *20001* (type).

Macrophoma Cercis Tehon & Stout, n. sp.

Foliicolous. Spots measuring up to 8 mm. long, circular when small, becoming oblongate and somewhat angular by being limited by the leaf veins; the margin definite, dark brown; the inner part of the spot light tan. Pycnidia abundant, not gregarious, developed in and occupying the mesophyll, opening epiphyllously by a slightly papillate ostiole, flattened-globose, dark brown, composed of a densely interwoven hyphal structure (a sort of meandering plectenchyma), 110–185 μ in diameter; ostiole round or angular, sometimes showing a darkened rim when rounded, 12–15.5 μ across. Spores 1-celled, hyaline, ovoid to long-ellipsoid and sometimes somewhat irregular, 13–23 $\times$ 4.5–7.7 μ, produced at the tips of simple, definite, hyaline sporophores.

On leaves of *Cercis canadensis*.

Venedy, Washington County, September 8, 1926. Acc. No. *19972* (type).

Macrophoma Phlei Tehon & Stout, n. sp.

Foliicolous. No evident spots. Pycnidia appearing abundantly on dry, dead leaves from tip to sheath subsequent to fruiting of host, not gregarious but disposed in rows closely adjacent to the leaf veins, membranous, subcarbonous, or completely carbonous, developed in and occupying the mesophyll, rotund or applanate in longi-sections, often oval in outline, the long axis parallel with the vein when viewed from above, 105–225 μ in diameter. Erumpent hypophyllously only. Ostiole papillate, at first closed by a thin, cellular membrane which dissolves when the spores mature and leaves a very distinct, irregularly circular stoma 17–28 μ in diameter. Spores hyaline, continuous, oval, 18–26 $\times$ 6.4–7.7 μ.

On *Phleum pratense*.

Wayne City, Wayne County, November 8, 1926. Acc. No. *19413* (type).

This is, in all respects except spore color, similar to *Sphaeropsis Phlei* Ellis & Ev.; but in our specimen all the marks of maturity are present, including the ability of the spores to germinate. It seems proper, therefore, to record this as a distinct form.

Exophoma astericola Tehon & Stout, n. sp.

Colonies foliicolous, chiefly hypophyllous, gray, irregular or subcircular, 5–20 mm. in diameter or more extensive by con-

fluence. Mycelium abundant, chiefly external, hyaline, irregularly and copiously branched, 4–4.5 μ in diameter. Pycnidia abundant, entirely external, brown, membranous, subspherical to ovoid, astomatous until maturity, 35–77 $\times$ 22–45 μ, raised beyond the hyphal weft by a cellular stalk of variable length and width. Ostiole very variable, appearing as a rupture of the pycnidium's apex, often apparently but not truly rostrate, 10–14 μ wide. Spores 1-celled, hyaline to smoky, ellipsoid, 4–5 $\times$ 7–10 μ, usually covered with a perceptible gelatinous film.

On *Aster tardiflorus*.

Paris, Edgar County, November 4, 1926. Acc. No. *19386* (type).

Cyphellopycnis Tehon & Stout, n. gen.

Pycnidia much longer than broad, membranous to carbonous, of somewhat irregular outline, containing a single cavity which opens to the outside by numerous, irregularly placed, often confluent ostioles. Spores hyaline, 1-celled.

This genus, erected to contain the following species, belongs in the Phomataceae, but, as far as we can ascertain, represents a type of pycnidium not heretofore noticed. The pycnidial structure houses a unified cavity, in which there is no sign of the locular separation which would naturally be expected from the numerous ostioles.

Cyphellopycnis Pastinacae Tehon & Stout, n. sp.

Caulicolous. Not maculicole. Pycnidia immersed, discrete, in linear series between the sclerenchyma fibers of the stem, spherical, oval, or elongate, 400 up to 2,000 μ long, outline irregular. Ostioles several to many, erumpent, 50 to 75 μ or more wide, separate or confluent, and definitely delineated by a dark border. Spores hyaline, oval to ellipsoid, usually very distinctly biguttulate, 7.7 $\times$ 2.2 to 13.2 $\times$ 2.4 μ but ordinarily 8.5–11 $\times$ 2.2 μ. PLATE 13, FIG. 5.

On *Pastinaca sativa*.

Arnold, Morgan County, July 20, 1926. Acc. No. *13257* (type).

Cytospora sambucicola Tehon & Stout, n. nom.

Synonym: *Cytospora sambucina* Tehon & Daniels, Mycologia **19**: 122. 1927.

Not *Cytospora sambucina* Ellis & Barth. Erythrea **5**: 48. 1897.

The kindness of Elam Bartholomew prompted him to bring to our notice our unfortunate and erroneous duplication of name in "Notes—III." From our description, Mr. Bartholomew was of the opinion that we had renamed the species named by him and Mr. Ellis 30 years before and he presented us a portion of his original material with which to make comparison. We have studied both; and it seems to us that our more northern form ought to be regarded as distinct. In this, as in most cases of plant-inhabiting *Imperfecti*, it is exceedingly difficult to express in words the differences that are so evident to our eyes and that our experience tells us to value far more than the differences in measurements upon which we seem so confidently to depend. We may, however, append the following tabular comparison.

	Ostiolar Opening	Spores
C. sambucicola	Compound	4–6.5 μ long, 1–2.5 μ broad
C. sambucina	Simple	6–7 μ long, 1.25 μ broad

Diplodia acericola Tehon & Stout, n. sp.

Foliicolous. Spots diaphyllous, yellow to tan at first, dark brown at length, circular, 4–12 mm. in diameter; margin chocolate brown, ½ mm. wide, crenulate because limited by the veinlets. Pycnidia numerous, scattered, situated in the mesophyll, membranous but becoming dark and carbonous in the upper half, 150–195 μ in diameter, opening epiphyllously by a somewhat raised but hardly rostrate ostiole 12–16 μ wide. Spores dark green, oblong, 1-septate, the septum very dark and distinct, 19.8–26.4 × 8.8–13.2 μ.

On *Acer saccharum.*

Mt. Pleasant, Union County, July 7, 1926. Acc. No. *14104* (type).

The eight species of *Diplodia* hitherto noted on *Acer* fall into two general groups separable on the basis of their spore lengths, and the species themselves can be distinguished as follows:

Spores less than 20 μ long.
  Spores 10 to 15 μ long.
    Pycnidia disposed in linear series; spores 6–8 μ wide . . *D. subtectoides*
    Pycnidia scattered; spores 4–5 μ wide . . . . *D. microsporella*
  Spores 17 μ long, 9 μ wide . . . . *D. acerina*
Spores 20 μ or more long.
  Spores not over 25 μ long.
    Pycnidia disposed in linear series . . . . *D. subtecta*

Pycnidia scattered.
  Pycnidia "very minute" . . . . *D. minutissima*
  Pycnidia larger.
    Septum of spore very dark, distinct, and pronounced. *D. acericola*
    Septum and spore wall concolorous.
      On box elder . . . . *D. atrata*
      On other maples . . . . *D. petiolarum*
Spores more than 25 μ long . . . . *D. extensa*

Cryptostictis inaequalis Tehon & Stout, n. sp.

Foliicolous. Pycnidia numerous, scattered, erumpent, spherical, dark but membranous, 90–150 μ in diameter; ostiole not rostrate, circular, usually enclosed by a carbonous ring, 14–25 μ wide. Spores 3-septate, the central septum usually not in the middle of the spore, end cells shorter than the middle cells, the spore 11–16 $\times$ 2–2.5 μ. Cilia 1 at each end cell, not apical, 11–15 $\times$ 0.25–0.5 μ, hyaline.

On *Vitis rotundifolia*.

Murphysboro, Jackson County, August 23, 1926. Acc. No. *13698* (type).

Though it appears from our specimen that this fungus gains entrance to the plant it inhabits by making use first of dead tissue killed by the black rot organism (*Guignardia Bidwellii*), it is to be remarked that the black rot organism has not been able to fruit in spots occupied by the *Cryptostictis*. Spores of *C. hysterioides* Fuckel., reported on *Vitis* in Europe, are said to be 16 $\times$ 7 μ and without cilia.

Septoria Tecomaxochitl Tehon & Stout, n. sp.

Foliicolous. Spots diaphyllous, small, 0.25–1 mm. in diameter, subcircular, tan to cinereous, with a broad, purplish, diffused halo above but not below. Pycnidia few, 1 to 4 or rarely 5 per spot, scattered, located in the palisade and epidermis, spherical, 50–90 μ in diameter, brown, membranous, protruding by means of a slightly papillate, somewhat carbonized ostiole with a round aperture at first 10–18 μ in diameter but later widely opened. Spores hyaline, straight to slightly curved, filiform, with no visible septa, 1–1.5 μ wide by 30–44 μ long.

On *Tecoma radicans*.

Lawrenceville, Lawrence County, October 26, 1926. Acc. No. *20946* (type). Hardin, Calhoun County, September 18, 1926. Acc. No. *20958*.

Our species differs quite obviously from *S. Tecomae* Ellis & Ev., not only in its distinctly larger pycnidia, which are as a rule distinctly larger than those of the Ellis species, but also with respect to its spores, which are both shorter and narrower.

Pseudodictya Tehon & Stout, n. gen.

Leptostromataceae. Pycnidia dimidiate, separate, membranous or carbonous, more or less superficial. Spores dark, septate, spherical to somewhat elongate. Epispore smooth.

Based upon the following remarkable species, this genus appears to fall in the Leptostromataceae, and is most readily disposed of by aligning it with the Phaeophragmiae, though its spore characters are not those usually expected in that group.

Pseudodictya sassafrasicola Tehon & Stout, n. sp.

Foliicolous. Spots circular, diaphyllous, reaching diameters of 3.5–6.5 mm., light brown throughout with a somewhat diffused, dark brown to black margin. Pycnidia abundant, widely scattered, strictly epiphyllous, developed and remaining between the cuticle and the epidermis, round, dimidiate, membranous when young, completely carbonized when old, astomous, 135–180 μ in diameter, 20–28 μ high. Spores brown, spherical, globose, or elongate-globose and falcate, 2-septate, 8.5–11 μ wide, 8.5–11 μ in length. PLATE 13, FIG. 9.

On *Sassafras variifolium.*

Seymour, Champaign County, October 15, 1925. Acc. No. *9353* (type).

The peculiar shape and septation of the spore of this fungus is misleading when first seen under the microscope. Usually it rests on the longer surface and appears as a globose body with muriform septations, but when it is rotated under the cover glass it is seen to have three distinct cells, placed end to end. The center cell is much the largest and, of the remaining two, one is distinctly larger than the other. This lateral view reminds one of the spores of *Helminthosporium inaequalis.*

Leptothyriella Liquidambaris Tehon & Stout, n. sp.

Foliicolous. Spots diaphyllous, brown, circular, 1–5 mm. in diameter, concolorous, collapsed, fragile, crumbling with age. Pycnidia sparse, epiphyllous only, superficial, dimidiate, radiate, 91–112 μ in diameter, without an ostiole, but with a circular

central "cell," 10–14 μ in diameter, from which the hyphae of the pycnothyrium seem to spring. Spores oval to oblong, virescent-hyaline, non-septate, 8.4–10.2 $\times$ 6–6.8 μ. PLATE 13, FIG. 7.

On *Liquidambar styraciflua.*

Olmstead, Pulaski County, August 9, 1922. Acc. No. *1445* (type).

We can not be wholly satisfied with the present disposition of this fungus. The "central cell," referred to in the description as being the point from which the pycnothyrial strands emanate, is apparently the apex of a stalk which connects with the internal mycelium and from which the sporophores are derived also. The entire group of pycnothyrial forms needs careful study.

Diplopeltis sassafrasicola Tehon & Stout, n. sp.

Foliicolous. Spots diaphyllous, very irregularly circular, 3–10 mm. in diameter, dark brown above when young, with a distinct, conspicuous, purplish marginal line, turning to a faded tan or cinereous, becoming friable and falling away with age, less distinct hypophyllously where the bloom of the leaf obscures the character. Pycnidia subcuticular, epiphyllous, few per spot, sparsely scattered, black, distinctly carbonized and impervious to transmitted light, circular in outline, in longitudinal section very flatly dimidiate, 120–270 μ in diameter, up to 64 μ high. Ostiole 7.5–14 μ in diameter, round, indistinct until the spores mature. Spores brown, 1-septate, typically oblong, with rounded ends, not perceptibly constricted, 18.5–22 $\times$ 7.5–11 μ. PLATE 13, FIG. 8.

On *Sassafras variifolium.*

Thebes, Alexander County, July 17, 1922. Acc. No. *581* (type).

The fungus is referred to *Diplopeltis* with hesitation. There are no characters to exclude it, if the Engler & Prantl characterization is followed; but if the characterization of the genus, and of the one previously described species, as given by Saccardo in the Sylloge is followed, it is doubtful whether this can be admitted, for the pycnidial cover, though parenchymatic, bears no indication, even in young pycnidia, of a radiate development.

The following species are being recorded either for the first time for Illinois or for the first time since the early collections

made in the State from about 1880 to 1890 by A. B. Seymour, F. S. Earle, M. B. Waite, and G. P. Clinton, and are represented by specimens deposited in the Mycological Collection of the Illinois State Natural History Survey.

Erysiphe Martii Lév. has been taken on *Urtica gracilis* near Fairview, Mason City, Rock Falls, and Wayne. These localities seem to indicate a state-wide distribution, though the fungus evidently is not common.

Mycosphaerella lethalis Stone, on *Melilotus alba*, is represented by a single specimen taken near Pearl City in the extreme north of the State.

Melanopsichium austro-americanum (Speg.) G. Beck. has been taken on *Polygonum pennsylvanicum* near Springfield.

Ustilago Cenchri Lagerh. has been collected once on *Cenchrus carolinianus* in the Illinois River sands near Beardstown.

Ustilago hypodytes (Schlecht.) Fries, collected by Clinton on *Stipa spartea*, has been found near Minier on *Stipa avenacea.*

Ustilago Rabenhorstiana Kuhn has been found on *Digitaria sanguinalis* near West Union. This fungus was collected in 1882 by Seymour on *Panicum glabrum* (*D. humifusa*) in 2 localities in northern Illinois, and on *Panicum sanguinale* in 1881 at Anna, Cobden, Monticello, Twin Grove, and in Henry County.

Ustilago Panici-glauci Wint. has been found in the vicinity of Urbana on *Setaria glauca.*

Urocystis Agropyri (Preuss.) Schroet. has been collected on *Elymus virginicus* near Atlanta, DeSoto, and Onarga. The increasing abundance of this grass along roadsides will probably be followed by an increased abundance of the smut.

Coleosporium Viburni Arth. (II) has been taken on *Campanula americana* near the towns of Henry and Mapleton.

Puccinia angustata Peck, hitherto found on *Scirpus cyperinus* (M. B. Waite, 1889) and *S. atrovirens* (A. B. Seymour, 1881, and M. B. Waite, 1885), has been found also on *S. polyphyllus* near Stronghurst.

Puccinia canaliculata (Schw.) Lagerh., reported by Kern (Mycologia **11**: 134. 1919) as occurring on *Cyperus strigosus*, has been collected in the vicinity of Thompson on *C. Schweinitzii.*

Puccinia Bardanae Corda has been found on *Arctium lappa* in

seven localities ranging from southern to extreme northern Illinois.

Phyllosticta sorghina Sacc. has been taken on *Holcus Sorghum* (broom corn) near Mattoon.

Phyllosticta Sassafras Cooke has been found near Marshall on *Sassafras variifolium.*

Phyllosticta orobella Sacc. has been found twice along the Illinois River, once on an unnamed *Lathyrus* and once on a legume not determined further by the collector.

Septoria sonchifolia Rob. & Desm. has been taken on *Sonchus oleraceus* at Colona, DuQuoin, and Fisher. The wide separation of these stations indicates a general distribution of the species.

Septoria Agrimoniae Roum. has been collected on *Agrimonia* sp. at Lilly, Aledo, and Mt. Sterling. The three stations are all in the northwest quarter of the State.

Septoria Agropyri Ellis & Ev. has been found on *Agropyron repens* at Lebanon and Mt. Carroll.

Septoria bacilligera Wint. has been identified on *Ambrosia trifida* at East Peoria, Kampsville, and McLeansboro—another species of wide distribution but of comparatively rare occurrence.

Septoria Bromi Sacc. has been collected on *Bromus secalinis* at Chester, Equality, Kampsville, Ridgway, Sparta, Waterloo, and White Heath and on *Elymus virginicus* at Arthur and Bement.

Septoria Brunellae Ellis & Holw. has been taken on *Prunella vulgaris* at 21 stations, reaching from the southern to the northern boundary of the State.

Septoria Campanulae (Lév.) Sacc. has been taken on *Campanula americana* at four stations and seems to have a range occupying a region just south of the middle of the State.

Septoria Commonsii Ellis & Ev. has been taken on *Cirsium lanceolatum* at three stations, all in the northern half of the State.

Septoria conspicua Ellis & Mart. has been taken on *Steironema ciliatum* at five widely separated stations and once on *S. lanceolatum* at Cisne.

Septoria Pileae Thuem. has been found on *Pilea pumila* at Lawrenceville.

Septoria Physostegiae Ellis & Ev. was taken on an undetermined species of *Physostegia* at Oregon.

Gloeosporium septorioides Sacc. has been collected on *Quercus alba*, *Q. imbricaria*, and *Q. macrocarpa*. The five stations represented by our specimens seem to indicate that this fungus is far more common in the southern than in the northern half of the State.

Gloeosporium fraxineum Peck has been taken once on *Fraxinus quadrangulata* at Oregon.

Gloeosporium Equiseti Ellis & Ev. has been collected on *Equisetum arvense* at Morton, Oregon, and Rochelle, and is apparently entirely northern.

Gloeosporium musarum Cooke & Massee, on *Musa sapientum*, has been taken at Mt. Carmel and Mt. Vernon.

Cladosporium Triostei Peck, on *Triosteum aurantacum*, has been collected at Stronghurst.

Cladosporium Pisi Cooke & Massee, on *Pisum sativum*, has been found at Normal.

Septogloeum subnudum Davis, on *Smilax hispida*, has been collected in the woods along the banks of the Sangamon River near Seymour.

ILLINOIS STATE NATURAL HISTORY SURVEY,
URBANA, ILLINOIS

EXPLANATION OF PLATE 13

Fig. 1. *Stigmatophragmia sassafrasicola.* An ascus, with spores and paraphyses.

Fig. 2. *Melanospora interna.* A spore, showing hyaline ends and the coarse, irregular reticulation of the wall.

Fig. 3. *Metasphaeria Asparagi.* An ascus, showing the shape, the thick apical wall, and the loose arrangement of the 4-celled spores.

Fig. 4. *Pleospora Oleraceae.* Two spores, showing septation and variation in size.

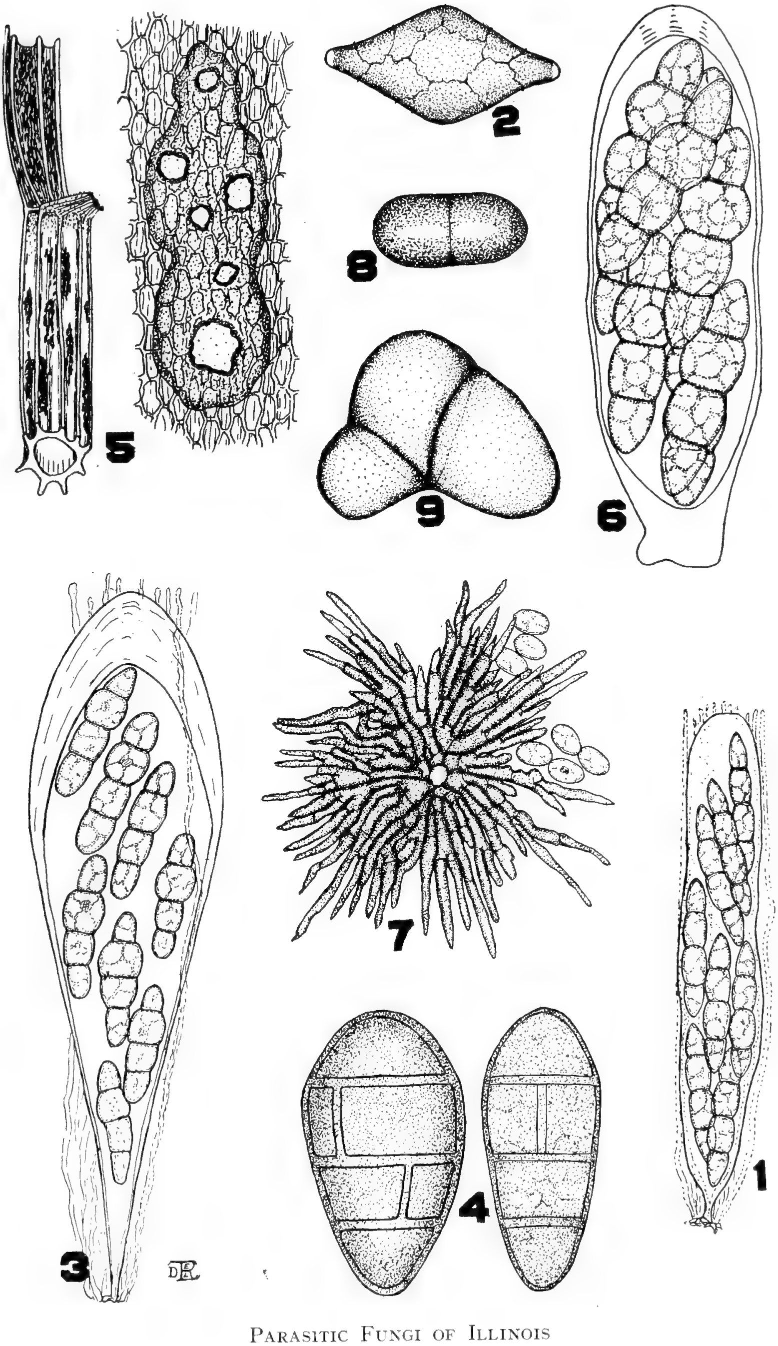
Fig. 5. *Cyphellopycnis pastinacae.* Habitat sketch, showing the fungus in blotches on a piece of a parsnip stem, and a typical pycnidium with several ostioles of varied sizes.

Fig. 6. *Metasphaeria sassafrasicola.* An ascus, showing the shape, the large foot, the double wall, and the arrangement of spores.

Fig. 7. *Leptothyriella Liquidambaris.* Pycnothyrium, showing the radiate structure and the relative size of the spores which issue from beneath its edge.

Fig. 8. *Diplopeltis sassafrasicola.* A spore, showing shape, septation, and very slight constriction.

Fig. 9. *Pseudodictya sassafrasicola.* Side view of spore, showing the large middle cell and the unequal end cells.



PARASITIC FUNGI OF ILLINOIS

NEW MEDIA FOR DEVELOPING SPOROPHORES OF WOOD-ROT FUNGI

Bessie E. Etter

(With Plates 14 and 15)

Introduction

For several years the writer has been experimenting with various culture media which would produce typical sporophores of wood-rotting fungi under control conditions in the laboratory. Long and Harsch [1] were able to grow many wood-rotting fungi in test tubes or small flasks containing agar decoctions; although fruiting bodies with typical hymenia and spores were often obtained, these were invariably undersized and in most instances without true pilei. Many of these experiments were repeated and a large number of sporophores obtained similar to those reported by Long and Harsch. In addition to this, sporophores with true pilei were grown inside small flasks. In every case the production of such sporophores was limited to fungi having a central stipe and a pileus which is normally not more than a half to one inch in diameter, such as *Polyporus perennis*, *Coprinus micaceus* and other similar fungi. However, the pilei thus produced, while of full size, did not have the typical zones and markings that characterize these species when grown in the open.

Small sporophores were also produced in flasks or test tubes of fungi which have large sporophores, such as *Pleurotus ostreatus*, *Lentinus lepideus*, etc., but such pilei were entirely lacking in the specific characters which determine these species when grown in nature. In the course of these experiments hundreds of small sporophores of wood-inhabiting fungi have been grown in flasks and test tubes, but rarely did such pilei have any markings or zones which would identify the species. The experiments so

[1] Long, W. H., and Harsch, R. M. Cultures of wood-rotting fungi on artificial media, Jour. Agr. Research **5**: 33–82. January 1918.

far conducted indicate that typical, well-marked, pileate sporophores of most fungi can not be developed inside containers. It seems that the zones, whether they be of hairs, scales or colors, must have open air conditions for normal development.

CULTURE MEDIA

It was soon found that the ordinary agar decoction, even in as large a vessel as a liter flask, apparently did not contain enough nutriment to produce typical sporophores of the larger fungi. Of course by using very large containers, which in an ordinary laboratory would not be practicable, sporophores of normal size might be produced, but even then the zones and markings would not be characteristic of the species in question. Therefore, experiments were begun with more or less solid media, such as sawdust, ground wood, corn-meal, starch, etc. Not only was a sufficient quantity of the solid nutrient necessary, but a more or less porous condition had to be maintained in the medium after sterilization; otherwise the hyphae would be limited mainly to the surface and sub-surface layers of the medium where they often could not obtain enough food to produce a large sporophore. It has been very difficult to obtain media sufficiently porous and yet containing enough moisture to keep the fungi in vigorous growth. In many instances the fungus would soon over-run the surface and produce a dense mat of mycelium which seemed to prevent the formation of sporophores.

To obtain the porous condition necessary many different materials were tried but so far none has been found that could be called a complete success for all species of fungi. Sponges soaked in various agar decoctions were tried but in every instance the heat of the autoclave, during sterilization, flattened the sponge and destroyed the porous condition which was so desired. Then blotting paper, filter paper, etc., were tried by making rolls in which there were alternate layers of the solid media and the porous paper soaked with liquid, but for some reason the fungous threads did not readily penetrate the layers of porous paper. Sphagnum moss mixed in varying proportions with the solid media was the best material found for increasing the porosity.

Various combinations of solid materials have been tried with more or less success; however, no medium was found which contained enough available initial liquid food to bring a large sporophore to maturity. It is, therefore, necessary to add liquid to the media after the cultures have been growing for a certain length of time.

For many wood-rotting fungi on conifers a very satisfactory culture medium for producing large sporophores is the following:

Corn-meal (white Quaker)	48 grams
Corn-starch (Kingsford)	16 grams
Powdered pine wood (*Pinus edulis*)	8 grams

To these solids is added a certain amount of malt liquid, made by adding 25 grams of malt extract to one liter of water. The quantity of this liquid to be added will of course be determined by the amount of solids used and the size of the container in which the fungi are growing. The malt preparation should not only saturate the solids used but should fill the flask about $\frac{2}{3}$ full, leaving the upper $\frac{1}{3}$ of the solids exposed to the air in the flask.

Flasks from 250 to 500 cc. were used. A 250 cc. flask was rather small; so the 500 cc. was generally used, although well developed, full size, characteristic sporophores of *Lentinus lepideus* were obtained by the use of either size flask. In some of the tests no sphagnum moss was added to the media (PLATE 14A) while in others this moss was used (PLATE 14B). In either case good sporophores were obtained. If the sphagnum is used the 500 cc. flasks are necessary in order to obtain the amount of nutrient material for the full development of the sporophores since the sphagnum occupied about one half of the space.

Cane-sugar was substituted in some cases for the corn-starch but with poor results. The main difficulty encountered in the use of the corn-starch was the swelling and gelatinizing of the starch granules, thus tending to destroy the desired porosity of the media. Any coniferous wood can be used if it is soft enough to produce a fine powder or flour. The powdered sap-wood of Western yellow pine (*Pinus ponderosa*), Mountain white pine (*Pinus flexilis*), Pinon (*P. edulis*), and Engelmann spruce (*Picea Engelmanni*) have been used with success. Powdered cotton-

wood was used instead of powdered pine for the production of the sporophores of fungi which attack hardwoods, the remainder of the formula being the same as that used for the conifers. For the growing of sporophores from fungi which attack certain forms of wood such as junipers, red-wood, oaks, etc., the powdered wood of these species in question was used.

Preparation of the Powdered Wood

The most important thing is to have the wood in as *finely powdered condition* as possible so that it will be readily and quickly available for fungous growth when a sufficient amount of moisture is present. The wood is powdered by holding it against a rapidly revolving disc driven by an electric motor. Coarse sandpaper is attached to the surface of the disc. Garnet sandpaper No. 2½ was found the most satisfactory since this paper was fine enough grained to produce a dust-like powder, but was coarse enough so that any oils or resins present in the wood would not gum the sandpaper and thus stop the powdering action. Several kinds of wood flour were made in advance and kept in paper boxes properly labeled.

In the earlier experiments one half of the media was wood powder but this large amount was found unnecessary for producing the desired sporophores and was very wasteful of the powdered wood. This last is an important item, for the powdering of the wood is a tedious and time-killing process. The amount of powdered wood given in the present formula was found sufficient to produce large sporophores of the various fungi tested. The solid portions of the media consisting of corn-meal, starch, and wood powder were thoroughly mixed in considerable quantities and kept in paper boxes ready for use at any time. The mixture, in the dry climate of Albuquerque, keeps perfectly without any signs of molding or mildewing. In damper climates it might be necessary to keep it in glass containers with airtight tops, like candy jars.

Sterilization of Media

After the proper amount of the malt liquid is added to the solid portions of the media, the flasks are plugged with cotton

in the usual manner and sterilized in an autoclave at about 8 lbs. pressure, for at least one hour. The flasks must not be too full; otherwise the swelling of the solid portions of the media during sterilization and the often uneven pressure between the inside and the outside of the flask will cause the media to wet the plugs or even push them out.

The Adding of the Malt Liquid

Flasks proved satisfactory when the fungi used had well pronounced stipes. The method of procedure in such cases was as follows: The flasks with the proper amount of media in them are first plugged and sterilized and then inoculated with the fungi to be tested. As the fungus develops more liquid medium is added when necessary. It is important that this food be added at the proper time and with extreme care, to prevent contamination. The most satisfactory method of adding this malt was found in the use of large test tubes 25 by 200 mm. in size. These were filled about ⅔ full of the malt liquid, then plugged and sterilized in the usual manner. Whenever the liquid food was added to the cultures the mouths of the tubes and of the culture flasks were flamed and the entire contents of the test tube were poured into the culture.

The time at which the malt should be added to the cultures is of vital importance and is one that can be determined only by observation and experience. This varies with the fungus under investigation and often several trials must be made before the proper time can be determined. With typical stipitate sporophores, the best time to add the liquid media is usually when the young and growing stipe has become clearly differentiated and is about an inch tall. The disappearance of the liquid in the flask and the slowing down of the growth of the ascending stipe indicate when more malt is needed. Two or three additions of malt are usually sufficient to bring the sporophore to full maturity.

Development of the Sporophores

The growth of the sporophore in the flask usually proceeds very rapidly and the ascending stipe soon reaches the cotton plug. At this stage the plug is withdrawn, spread over the top

of the flask and held in place by rubber bands or strings. Of course, the sterilized portion of the plug after spreading should still be above the mouth of the flask. It is an easy matter for the ascending sporophore to push its way through the cotton covering into the outside air. The pileus will usually expand very rapidly if a sufficient amount of liquid medium is maintained in the flask. At this stage, the surface of the culture in the flask will be so thoroughly matted with felts of mycelia that no visible contamination will appear until long after the sporophore has completed its growth, discharged its spores and become dry.

The length of time between the inoculation of the culture media and the formation of perfect sporophores varies with the fungus. Perfect sporulating sporophores of *Lentinus lepideus* (PLATE 14) were obtained in from six to eight weeks after inoculation; with *Pleurotus ostreatus* this period was somewhat shorter. Typical pileate sporophores of the following wood rotting fungi have been grown on the media described: *Lentinus lepideus*, *Pleurotus ostreatus*, *Coprinus micaceus*, *Coprinus atramentarius*, *Xerotus* sp., *Pholiota* sp., *Polyporus arcularius*, *Polyporus perennis*, *Polyporus Farlowii*, *Ganoderma Curtisii*, *Ganoderma polychromum*, *Ganoderma* sp. and *Trametes Peckii*. The stipitate forms were grown by the flask method described in this paper, while the bracket fungi were grown on the same media but by a different method, which will be discussed in a later paper.

SUMMARY

1. Media have been developed which produced characteristic pilei, normal as to size and markings, of the wood rotting fungi tested.

2. The media used consisted of mixtures of corn-meal, starch, wood flour and malt liquid.

3. The cultures grew rapidly on these media and soon developed typical sporophores.

4. Media for growing sporophores of the larger fungi apparently must contain wood in some form in order to produce pilei of normal size.

5. Wood flour is the best of the materials tested since it is immediately available for use by the growing fungi.

Lentinus lepideus (× 9/10) in 250 cc. Flask with No Sphagnum Moss in Medium. Shows Typical Markings on Stipe

Lentinus lepideus (× 9/10) in 500 cc. Flask with Sphagnum Moss Added to Medium. Shows Characteristic Markings on Surface of Pilei.

6. Liquid media must be added to the growing cultures to produce normal pilei of fungi which have large sporophores.

7. Pilei normal as to size and markings would not develop *inside* containers of ordinary size.

8. The sporophores must extend beyond the mouth of the container into the outside air to produce characteristic pilei.

9. The flask method described is especially adapted to fungi having stipitate sporophores.

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CONTRIBUTIONS TO A MYCOLOGICAL FLORA OF LOCAL SOILS

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(With Plates 16–19)

This investigation has been undertaken with the purpose of initiating observation of the fungous flora of the soils of Illinois. Studies of this nature have been made in a number of states, but none has been reported from Illinois up to the time of the present one. This work was carried on in Evanston, Illinois, during the year 1927–1928 under the helpful supervision of Dr. Alfred H. W. Povah.

Materials

The materials employed were sterile test tubes, petri dishes, a scalpel and an alcohol lamp. Soil samples were taken during the months of October and November, 1927, while the earth was still unfrozen, from the surface and at depths varying from five to one hundred and twenty centimeters. Complete collection data are recorded in Table I.

Method

Before taking a soil sample, a few cubic millimeters of soil were scraped away with a flamed scalpel to eliminate possible surface contamination. Where samples were secured from the side of a ditch, several cubic centimeters of soil were removed, in order to avoid surface and air fungi. After being flamed, the test tube was forced to a depth of three or four centimeters into the soil, withdrawn, and stoppered. Blakeslee's (**21**) malt extract agar was the principal medium used in the study, as it favored luxuriant growth of a large proportion of the species examined. In addition to agar, moist bread in wide-mouth 250-cc. bottles, which had been autoclaved for two hours at fifteen pounds steam pressure, was used for the cultivation of species of Mucorales. Sterile green beans were also used for the growth of a number of

Fungi Imperfecti in order that the most favorable development might be obtained.

TABLE I

SOIL COLLECTION DATA

No.	Date	Type of Soil [1]	Depth
1	9/30/27	Black, filled with small roots	5 cm.
2	9/30/27	Black, free of roots	15 cm.
3	9/30/27	Light-colored, sandy	25 cm.
4	10/ 3/27	Sand and loam, stony	60 cm.
5	10/ 3/27	Black, filled with grass roots	5 cm.
6	10/ 3/27	Dark, mixed with sand and some clay	60 cm.
7	10/ 3/27	Light-colored, loose, sandy	90 cm.
8	10/ 3/27	Dark, some clay	120 cm.
9	10/12/27	Dry sand from shore of Lake Michigan, 39 cm. from water's edge	Surface
10	10/12/27	Wet sand from beach, just at water line	Surface
11	10/13/27	Cinders mixed with sand	5 cm.
12	10/13/27	Sand with slight admixture of cinders	15 cm.
13	10/13/27	Sand with loose stones	45 cm.
14	10/20/27	Garden soil; humus containing leaf mold	Surface
15	10/20/27	Dark moist humus, uncultivated	Surface
16	10/22/27	Uncultivated leaf mold	Surface
17	10/24/27	Dark leaf mold, uncultivated	Surface
18	10/28/27	Rich uncultivated humus	Surface
19	11/ 3/27	Dark sandy, from canna bed	Surface
20	11/10/27	Sandy, from cultivated conifer bed	Surface
21	11/10/27	Dark humus, from area wooded with oaks	Surface
22	11/10/27	Dark, from uncultivated open meadow	Surface

In all cases, strict precautions were taken to avoid contamination of the media and instruments. All glassware was sterilized in a hot air sterilizer at 150° C. for a period varying from forty-five minutes to one and one-half hours. Instruments such as needles, spear-points, wire loops and scalpels were flamed before use. The greatest care was taken in culture work to prevent contamination by spores present in the air of the laboratory. Such work was done under a glass case the interior of which had been washed with mercuric chloride solution (1–1,000).

After a tube of soil had been brought into the laboratory, sterile water was poured into it until the soil was thoroughly moistened and approximately a centimeter of clear liquid remained above the soil surface. The tube contents were then shaken vigorously at intervals of five to ten minutes until the soil was well "washed." Allowing a few minutes for the coarser

[1] Samples below the surface were obtained from the sides of a freshly dug trench, in uncultivated soil.

particles to settle, while the lighter ones such as fungal spores were still suspended, a flamed wire loop was dipped into the partially cleared liquid, and the droplet thus obtained was touched at several points on a poured agar plate. This process was repeated a number of times with each sample, so that two to three petri dish cultures were made from every collection of soil. The plates were then set aside and the fungi allowed to develop. The laboratory temperature averaged 20–22° C. during the day, but at night and over week-ends it fell frequently to 10–15° C. From the petri dish cultures, pure single spore isolations were made by the dilution method.

Clements' *Genera of Fungi* (**6**) was used most extensively in the determination of genera of the forms isolated in this study. In the identification of Mucors the works of Lendner (**13**), Van Tieghem (**29**) (**30**) (**31**), Hagem (**9**) (**10**) and Povah (**21**) were used. The key of Thom and Church (**28**) was employed in the identification of *Aspergilli.* In connection with the Fungi Imperfecti the writer found Rabenhorst (**4**) (**15**) and Engler and Prantl (**14**) of valuable assistance. Saccardo (**25**) was used repeatedly for general reference.

The Fusaria isolated were not referred to species, due to the unorganized state of the genus, but were merely placed in the "sections" indicated by Wollenweber, Sherbakoff et al. (**36**).

The writer is indebted to Dr. Charles Thom for the identification of a number of species of *Penicillium*, grateful acknowledgment of which is made at this time.

RESULTS

A list of the species of fungi isolated, arranged alphabetically, is given in Table II, with an indication of the depth in the soil at which each was found.

In the pure sand from the beach of Lake Michigan, three of the higher fungi were found: *Rhizopus nigricans*, an *Actinomyces* (described as *Actinomyces* IV), and a pink yeast.

Several forms apparently belonging to the *Actinomyces* group were observed in the course of this study, but they were not identified. A macroscopic description of each is given. Several yeasts, distinguishable by their color, were also noted, but no attempt was made to identify them.

TABLE II

VERTICAL DISTRIBUTION OF FUNGI ISOLATED FROM SOIL

Species	Surface	5 cm.	15 cm.	25 cm.	45 cm.	60 cm.	90 cm.	120 cm.
Actinomyces I	...	...	...	...	...	*		
Actinomyces II	...	...	...	...	...	*		
Actinomyces III	...	...	...	...	*			
Actinomyces IV	*							
Alternaria humicola Oud	**	*	...	*				
Aspergillus fumigatus Fres	...	**	*					
A. luchuensis Inui	***	**						
A. niger Van Tiegh	***	**	**					
Chaetomium subterraneum Swift & Povah	...	...	...	...	...	...	...	*
Circinella simplex Van Tiegh	***							
Cunninghamella elegans Lendner	**							
Fusarium arthrosporiella Sherb	...	*						
F. elegans Wollen	***							
F. liseola (Sacc.) Wollen. (?)	**							
F. roseum Wollen	***							
F. sp.	*							
Hormodendrum cladosporioides Fres	***	**	*	*				
Mucor abundans Povah	**							
M. circinelloides Van Tiegh	***							
M. griseo-cyanus Hagem	***							
M. griseo-lilacinus Povah	***							
M. varians Povah	***							
Myrothecium convexum Berk	*							
Penicillium roseum Link	**							
P. pinophilum Hedgcock	***	**						
P. stoloniferum Thom	...	...	*					
P. III	...	**	...	*	...	...	*	
P. IV	...	*	...	...	...	*	...	*
P. V (monoverticillati series)	...	...	...	...	*			
P. VI (expansum series)	**							
P. Herquei Bainier	***							
P. oxalicum Currie & Thom	*							
P. IX	**							
Rhizopus nigricans Ehren	***	**						
R. nigricans var. minor Jensen	...	...	*					
R. nodosus Namysl	**							
Stachybotrys atra Corda	...	...	...	...	*			
Stysanus medius Sacc	...	...	...	*				
Trichoderma Koningi Oud	***	***	*	**	...	*	...	*
Trichosporium nigricans Sacc. f. lignicola	...	...	...	*				
Trichurus terrophilus Swift & Povah	...	...	...	*				
Verticillium lateritium Berk	...	...	...	...	...	...	*	
Zygorrhynchus Vuilleminii Namysl	***	***	...	**	...	*	*	
Z. Moelleri Vuill	...	*						
Approximate totals	80	26	7	10	3	5	3	3

* one isolation.
** two–three isolations.
*** four or more isolations.

In a review of the results of the present study, the writer found species of *Mucor*, *Aspergillus*, *Penicillium* and *Trichoderma* occurring most frequently, with *Zygorrhynchus*, *Rhizopus* and *Fusarium* also very common.

Two new species of fungi have been isolated and described; namely, **Chaetomium subterraneum,** found at a depth of 120 centimeters (Soil Sample No. 8), and **Trichurus terrophilus,** occurring at a depth of 25 centimeters (Soil Sample No. 3).

SPECIES ISOLATED

Identification of the fungi isolated constituted the principal part of this study. Following is a classification of the species found, with notations as to their occurrence. The numbers given in connection with the source of each species refer to Table I. In determining colors, Ridgway's *Color Standards and Color Nomenclature* (**24**) was followed.

I. PHYCOMYCETES.

A. MUCORALES.

1. SPORANGIOPHORAE.

a. MUCORACEAE.

Circinella simplex Van Tiegh. (PLATE 16, FIGS. 3, 4.)

This species was isolated from five different soils, cultivated and uncultivated, all taken at the surface (Nos. 14, 15, 17, 20, 21). Previously unreported from the soil.

Mucor abundans Povah.

This species was isolated twice by the writer from surface samples of dark sandy soil of cultivated canna bed (No. 19). Povah found this form in sandy tilled soil in Michigan in 1916.

Mucor circinelloides Van Tiegh.

Isolated repeatedly from surface soil taken from cultivated and uncultivated areas (Nos. 14–21). Previously reported from the soil by Jensen in 1912, Dale in 1914, Povah in 1916, Waksman in 1917, Pratt in 1918, and Takahashi in 1919.

Mucor griseo-cyanus Hagem.

Isolated several times from sandy, cultivated surface soil of flower bed, as well as from humus of wooded areas (Nos. 14, 16). Previously reported from the soil by Lendner in 1908 and Hagem in 1910.

Mucor griseo-lilacinus Povah. (PLATE 17, FIGS. 11, 12.)

This *Mucor* was found repeatedly in samples taken from the surface of cultivated and uncultivated sandy and loamy soils (Nos. 14–21). Previously unreported from the soil.

Mucor varians Povah.

This species was the most abundant in the collection of the writer. It was isolated many times from all surface samples, excepting those from the beach and from the open meadow. In collections from uncultivated soil (Nos. 15–18) the variation in form of columella was markedly less than in the other isolations. This species was found in tilled and untilled soil by Povah in 1916.

Rhizopus nigricans Ehren.

Found often in surface soils and less frequently at depths of 5 centimeters (No. 1). It also appeared on cultures from beach sand, with an *Actinomyces* and a pink yeast. On bread it formed a very dark turf reaching a height of 1–3 cm. after two weeks of growth. Isolated from the soil by Adametz in 1886, Hagem in 1907, Jensen in 1912, McLean and Wilson in 1914, Werkenthin in 1916, Waksman in 1917, Pratt in 1918, Rathbun in 1918, Takahashi in 1919, and Abbott in 1923.

Rhizopus nigricans Ehren. var. *minor* Jensen.

This variety was isolated from sandy filled-in soil containing some cinders, at a depth of 15 cm. (No. 12). Previously reported by Jensen in 1912.

Rhizopus nodosus Namysl.

This species was isolated twice from cultivated surface soil (No. 14). Previously reported from the soil by Hagem in 1907, Lendner in 1908, Jensen in 1912, and Waksman in 1917.

Zygorrhynchus Vuilleminii Namysl.

This fungus was found to be very abundant in all surface soils, and was also present in soils taken at depths of 5, 25, 60 and 90 centimeters (Nos. 1, 3, 5, 6, 7). It was the only representative of Mucorales in the soils taken from the open meadow (No. 22). Previously reported by Namyslowski in 1910, Jensen in 1912, Povah in 1914, Waksman in 1917, and Abbott in 1923.

Zygorrhynchus Moelleri Vuill.

Found by the writer but once. Its source was 5 cm. below the surface in loamy soil (No. 5). Previously found in the soil by Hagem in 1907, Jensen in 1913, and Paine in 1927.

2. CONIDIOPHORAE.

a. CHAETOCLADIACEAE.

Cunninghamella elegans Lendner.

This species was isolated twice from garden soil (No. 14). Previously reported from the soil by Lendner in 1908, Jensen in 1912, and Povah in 1914.

II. ASCOMYCETES.

A. SPHAERIALES.

1. SORDARIACEAE.

Chaetomium subterraneum Swift & Povah, sp. nov. (PLATE 19, FIGS. 6–11)

Forming on Blakeslee's agar circular *colonies*, at first grayish white, then slate blue-green gray and slightly iridescent, becoming deep olive gray and at maturity dark olive gray, almost black; reverse deep olive green; *mycelium* at first hyaline, later olivaceous, septate, 2–4 μ in diameter, aggregated in rope-like strands from which brown perithecia arise; *perithecia* 150–275 $\times$ 70–100 μ, spherical when young, becoming ovoid or flask-shaped, uniformly covered with mostly simple, straight, attenuate, six- to nine-septate, dark brown *setae*, 52–105 $\times$ 3 μ; setae with bulbous base 4–5 μ in diameter, often with elbow-turn just at swelling, sometimes very slightly undulating in upper half; shorter setae 20–30 μ long, often surrounding the ostiole; *asci* when young clavate, with short hyaline stalk, evanescent, sporogenous portion 21–30 $\times$ 8–14 μ, eight-spored, uniseriate; *spores* 7–10 $\times$ 5–7 μ, lemon-shaped, dark olive green, often containing one or more large oil globules, when young greenish in color and containing droplets of refractive substance.

While the hairs in **Chaetomium subterraneum** are typically unbranched, careful examination of the lower portion of the perithecia showed the occasional occurrence of hairs once branched near the base. Chivers (**5**) reports the occurrence of only one species of *Chaetomium* with unbranched straight terminal hairs, *Chaetomium trigonosporum* Marchal, but the shape of spores and the measurements of perithecia, hairs and asci do not agree with the above-described species.

This fungus was isolated from clay-mixed soil taken at a depth of 120 centimeters (No. 8).

III. **FUNGI IMPERFECTI.**

A. HYPHOMYCETES.

1. MUCEDINEAE.

a. MUCEDINACEAE.

Aspergillus fumigatus Fres. (PLATE 17, FIGS. 4–6.)

Isolated from humus at depths of 5 and 15 centimeters (Nos. 1 and 2). Previously reported from the soil by Waksman in 1917, Takahashi in 1919, and Paine in 1927.

Aspergillus luchuensis Inui. (PLATE 17, FIGS. 1–3.)

This species is a subdivision of the *niger* group of Thom and Church (**25**), and, though not reported under this name, has no doubt been found before in the soil and identified as *A. niger*. It was found repeatedly in surface soils by the writer, and several times at a depth of 5 centimeters (No. 5).

Aspergillus niger Van Tiegh.

Found repeatedly in surface soils and also at depths of 5 and 15 centimeters (Nos. 2 and 5). Previously reported by Dale in 1914, Waksman in 1917, Rathbun in 1918, Takahashi in 1919, Abbott in 1923, and Paine in 1927.

Penicillium roseum Link (?). (PLATE 16, FIGS. 7, 8.)

Isolated three times by the writer from cultivated surface soil. Also reported from the soil by Takahashi in 1919 and Paine in 1927.

Penicillium pinophilum Hedgcock.

Found repeatedly in surface soil and at a depth of 5 centimeters (No. 1).

Penicillium stoloniferum Thom.

Found at a depth of 15 centimeters (No. 2).

Penicillium sp. (III).

Colony low growing; spores forming powdery patches, Lincoln green; submerged mycelium white; numerous bright terra cotta perithecia formed over upper surface of colony and especially abundantly along the margins; reverse of culture on Blakeslee's agar honey yellow.

This species was found several times at a depth of 5 centimeters (No. 5), and once at 25 and again at 90 centimeters (Nos. 3, 7).

Penicillium sp. (IV).

Colony low growing, with leaf green powdery surface; submerged mycelium white. A few testaceous (Ridgway) perithecia are formed in clusters along margin of the culture. Reverse of colony clay color.

This *Penicillium* was taken from depths of 5, 60 and 120 centimeters (Nos. 5, 6, 8).

Penicillium sp. (*monoverticillati* series) (V).

Colony dusty with Lincoln green spore mass, concentrically zoned; submerged mycelium hyaline and inconspicuous; reverse of culture honey yellow.

A single isolation was made from the soil taken at a depth of 45 centimeters (No. 13).

Penicillium sp. (*expansum* series) (VI).

Old cultures Andover green, showing concentric zonation; spore production abundant; mycelium white, inconspicuous; reverse predominantly wood brown shading into Hay's russet.

Found several times in surface samples (Nos. 16, 17).

Penicillium Herquei Bainier.

Found repeatedly in surface soils (Nos. 14, 15, 18–22).

Penicillium oxalicum Currie & Thom.

This species was found in surface soil (No. 15).

Penicillium sp. (near to *aurantio-violaceum* Biourge) (IX).

Surface powdery with irregularly heaped Lincoln green spore mass; somewhat concentrically zoned; mycelium white; honey yellow resinous droplets concentrically arranged, covering surface of small terra cotta perithecia found principally at base of culture tube; reverse bright liver brown or Hay's russet.

This form was found several times in surface soils (No. 16).

Trichoderma Koningi Oud. (PLATE 18, FIGS. 4, 5.)

Isolated repeatedly from samples taken at the surface and from depths of 5, 15, 25, 60 and 120 centimeters (Nos. 2, 3, 5, 6, 8). Also found in the soil by Oudemans and Koning in 1902,

Jensen in 1912, Goddard in 1913, Dale in 1914, Waksman in 1917, Rathbun in 1918, Takahashi in 1919, and Abbott in 1923.

Verticillium lateritium Berk. (PLATE 16, FIGS. 5, 6.)

Found by the writer at a depth of 90 centimeters in sandy soil (No. 7). Previously unreported from the soil. In view of the fact that this fungus causes a serious disease of the Irish potato, its isolation from non-agricultural soil may have a significant bearing on the control of this disease.

2. DEMATIEAE.

a. DEMATIACEAE.

Alternaria humicola Oud. (PLATE 18, FIGS. 1, 2.)

This species was isolated by the writer a number of times from surface soils and at depths of 5 and 25 centimeters (Nos. 3, 5, 14). Reported from the soil by Koning in 1902, Dale in 1914, Waksman in 1917, and Abbott in 1923.

Hormodendrum cladosporioides Fres. (PLATE 18, FIG. 3.)

Found repeatedly in surface soils and at depths of 5, 15 and 25 centimeters (Nos. 1, 2, 5). Previously reported by Jensen in 1912, Goddard in 1913, and Paine in 1927.

Stachybotrys atra Corda. (PLATE 18, FIGS. 6, 7.)

Found by the writer in sandy soil at a depth of 45 centimeters (No. 13). Previously reported by Jensen in 1912.

Trichosporium nigricans Sacc., f. *lignicola*, as given by Saccardo.

Found by the writer at a depth of 25 centimeters in sandy soil (No. 3). Not previously reported from the soil, but Saccardo (**25**) indicates that it was found in France on decaying wood in association with *Hypocrea rigens*. This form, as developing in the writer's culture, offered a striking resemblance to the imperfect stages of a number of Ascomycetes related to *Hypocrea* (**32**), and might well be found upon investigation to be a stage in the life history of *Hypocrea rigens*.

3. STILBEAE.

a. STILBACEAE.

Stysanus medius Sacc.

This species was found by the writer at a depth of 25 centimeters in sandy soil (No. 3). Not previously reported as occurring in the soil.

Trichurus terrophilus Swift & Povah, sp. nov.
(PLATE 19, FIGS. 1–5)

Forming on Blakeslee's agar irregular *colonies*, at first pale olive gray with radial folds, becoming dark olive gray and finally olivaceous-black, always with pale margin, at maturity forming a dense and powdery growth up to 1.5 mm. in height, with small light-refracting droplets often on the surface; reverse greenish black; *mycelium* dark brown, septate, 2–3.5 μ in diameter, in early stage forming branched catenulate conidia on single hyphae. At maturity the mycelium adheres in rope-like strands from which arise vertically dark clavate *fruit bodies* 375–1300 μ tall, on stalks 95–800 $\times$ 20–70 μ, the fertile portion of the fruit body 135–500 $\times$ 35–150 μ, giving rise to simple or panicled chains of spores interspersed with bristle-like dark brown *setae* 15–70 μ in length, 3 μ wide at base, tapering gradually almost to the apex, which is terminated in a sharp point. Setae non-septate, or occasionally with one or two septa near the base, simple or forked, the two branches commonly of unequal length and forming an obtuse angle. *Spores* oval to elliptical, 3–6 $\times$ 2–3.5 μ, pale green, greenish black in mass.

This species was isolated by the writer from sandy soil at a depth of 25 centimeters (No. 3). Only three species of *Trichurus* are known: *T. cylindricus* Clements and Shear (**25**), *T. spiralis* Hasselbring (**11**), and *T. gorgonifer* Bainier (**25**). **T. terrophilus** differs from *T. cylindricus* in its much smaller spores, and from *T. spiralis* and *T. gorgonifer* in the form and branching of its setae, as well as in the smaller size of the spores.

4. TUBERCULARIEAE.

a. TUBERCULARIACEAE.

Fusarium arthrosporiella Sherb. (Sec. 5).

This *Fusarium* was isolated from loam at a depth of 5 centimeters (No. 5).

Fusarium elegans Wollen. (Sec. 13).

This fungus was found by the writer in surface soils (Nos. 14, 15, 21, 22).

Fusarium liseola (Sacc.) Wollen. (?) (Sec. 8).

The fungus isolated differs from typical *F. liseola* in that chlamydospores are present. It was found in surface soil (Nos. 14, 15).

Fusarium roseum Wollen. (Sec. 7).

This species was found repeatedly in surface soils (Nos. 15–22).

Fusarium sp.

This form does not fall into any of the sections described by Wollenweber et al. (**36**). It is comparatively slow-growing, with little aerial mycelium except at the edges of colony; surface of culture at first dull white, later sulphine yellow and somewhat powdery; sparse aerial mycelium white, with traces of red appearing when in contact with test tube; *microconidia* irregularly rod-shaped, 6–14 × 3–6 μ, 0–2 septate, sessile, guttulate; *macroconidia* sickle-shaped, 25–58 × 5–8 μ, three- to seven-septate, attenuate at tips; *mycelium* 3–7 μ in diameter, septate, aggregating in rope-like strands.

This species was found by the writer in surface soil (No. 20).

Myrothecium convexum Berk. & Curt. (PLATE 17, FIGS. 7–10.)

This species was isolated by the writer from sandy surface soil of cultivated conifer bed (No. 20). Previously unreported from the soil.

IV. ACTINOMYCES.

Actinomyces I.

Colony irregular in outline, prostrate, dull white at first, becoming creamy with age, wrinkled and folded similar to bacterial growth; surface somewhat powdery. This form was found at a depth of 60 centimeters (No. 4).

Actinomyces II.

Colony circular, at first white, then bright coral pink with hyaline margin, wrinkled radially, with a few strands of aerial white mycelium, forming a tough leathery growth on the surface of the substratum.

This species was found at a depth of 60 centimeters (No. 4).

Actinomyces III.

Colony at first circular, becoming irregular, presenting general appearance of bacterial growth, cream white; surface with numerous fine sinuous folds at center of culture.

This fungus was isolated from soil at a depth of 45 centimeters (No. 13).

Actinomyces IV.

Colony circular, shiny, at first white, then dull cream, folds extending radially, forming tough leathery membrane on surface of culture.

This *Actinomyces* was obtained from pure sand of the beach of Lake Michigan (No. 10).

TABLE III

WORLD DISTRIBUTION OF GENERA ISOLATED IN ILLINOIS

Genus	England (7)	Germany (1)	Holland (18)	Japan (26)	Norway (9)	Iowa (2) (19)	Idaho (22)	Mich. (8) (20) (21)	N. J. (16) (33)	N. Y. (12)	R. I. (23)	Texas (35)
Alternaria	*	...	*	*	...	*	...	...	*	*		
Aspergillus	*	*	*	*	...	*	*	*	*	*	*	*
Chaetomium	...	...	...	...	...	*	...	...	*	*	*	
Circinella												
Cunninghamella	...	...	...	...	...	*	...	*	...	*		
Fusarium	*	...	...	...	...	*	*	*	*	...	*	*
Hormodendrum	...	...	*	...	...	*	...	*	*	*		
Mucor	*	*	*	*	*	*	*	*	*	*	*	*
Myrothecium	...	...	...	...	...	...	...	...	*			
Penicillium	*	*	*	*	...	*	*	*	*	*	*	*
Rhizopus	*	*	...	*	*	*	*	*	*	*	*	*
Stachybotrys	...	...	...	...	...	*	...	...	...	*		
Stysanus	...	...	*	...	...	...	...	*	*			
Trichoderma	*	...	*	*	...	*	*	*	*	*	*	
Trichosporium												
Trichurus												
Verticillium	*	...	...	...	...	*	*	*	*			
Zygorrhynchus	*	...	...	*	...	*	...	...	*	*	*	

The numbers given above refer to the bibliography.

DISCUSSION

In Table III is shown the occurrence in other parts of the world of the genera isolated in this investigation. A comparison of Tables II and III will show a striking agreement between the genera found most frequently in local soils and those reported most frequently from other localities. The writer found species of *Aspergillus*, *Mucor*, *Penicillium* and *Trichoderma* to be most numerous, with *Fusarium*, *Rhizopus* and *Zygorrhynchus* ranking next. Table III indicates that these fungi are those most often

reported from other parts of the world. This would seem to indicate that these genera are not merely transients, but fairly constant inhabitants of the soil throughout the world.

However, in any examination of soil from a new region, new forms may be expected. Abbott (**3**) in 1926 assembled a list of fungi which had been reported up to that date as occurring in the soil. After a careful review of the literature since Abbott's publication, particularly the work of Paine (**19**) in 1927, the following species from Illinois soils are found to be herein reported for the first time: **Chaetomium subterraneum,** *Circinella simplex*, *Mucor griseo-lilacinus*, *Myrothecium convexum*, *Stysanus medius*, *Trichosporium nigricans* Sacc. f. *lignicola*, **Trichurus terrophilus,** and *Verticillium lateritium*.

Whereas the writer realizes that this investigation is by no means comprehensive, it should serve as an introduction to the assembling of a fungous flora of local soils, as an incentive for further work, in which possibly fungous physiology as well as taxonomy may be considered, and also as a contribution to the slowly growing body of evidence for a definite and characteristic mycological flora of the soil.

SUMMARY

Isolations of fungi from twenty-two samples of Illinois soil have been made. The soils ranged in type from pure sand of the shore of Lake Michigan to humus of wooded areas. Samples were taken from cultivated and uncultivated areas, at the surface and at depths of 5, 15, 25, 45, 60, 90 and 120 centimeters.

Examination of pure cultures of the fungi yielded thirty-nine species and one variety, belonging to eighteen different genera. In addition, four *Actinomyces* and several yeasts were observed.

Fungi were most numerous at the surface of the soil, decreasing markedly with depth. A few forms, however, were found to be present at depths heretofore unexamined; namely, *Actinomyces* spp., *Penicillium* sp., *Trichoderma Koningi*, and *Zygorrhynchus Vuilleminii* at 60 centimeters; *Penicillium* sp., *Verticillium lateritium*, and *Zygorrhynchus Vuilleminii* at 90 centimeters; and **Chaetomium subterraneum,** *Penicillium* sp., and *Trichoderma Koningi* at 120 centimeters.

In tilled areas species of *Mucor* were dominant; in untilled areas they occurred only sparsely.

In surface soil species of *Mucor*, *Aspergillus* and *Penicillium* were most numerous; in sub-surface soil, *Penicillium* spp., *Trichoderma Koningi*, and *Zygorrhynchus Vuilleminii* appeared more frequently than other forms.

The following eight species are herein reported for the first time as occurring in the soil: **Chaetomium subterraneum** Swift & Povah, sp. nov., *Circinella simplex* van Tiegh., *Mucor griseo-lilacinus* Povah, *Myrothecium convexum* Berk., *Stysanus medius* Sacc., *Trichosporium nigricans* Sacc. f. *lignicola*, **Trichurus terrophilus** Swift & Povah, sp. nov., and *Verticillium lateritium* Berk.

Chaetomium subterraneum and **Trichurus terrophilus** are described as new species.

The conclusions of previous workers with regard to the genera found most commonly in the soil: namely, *Aspergillus*, *Fusarium*, *Mucor*, *Penicillium*, *Rhizopus*, *Trichoderma*, and *Zygorrhynchus*, are confirmed by the present work.

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EXPLANATION OF PLATES

Measurements based on original drawings which were reduced about one-third in reproduction

PLATE 16

Trichosporium nigricans Sacc. f. *lignicola*

Fig. 1. Swollen mycelium, showing oil globules and chlamydospores. (× 1000.)

Fig. 2. Septate mycelium, bearing globular, guttulate conidia on short conidiophores. (× 1000.)

Circinella simplex van Tiegh.

Fig. 3. Habit sketch of conidiophore, showing manner of branching. (× 20.)

Fig. 4. Detail of sporangiophore. *A*. Columella (× 375) and spherical spores (× 750). *B*. Spherical sporangium. (× 375.)

Verticillium lateritium Berk.

Fig. 5. Detail of verticillately branched conidiophore. (× 1000.)

Fig. 6. Conidia. (× 1000.)

Penicillium roseum Link (?)

Fig. 7. Conidiophore, showing secondary branches and attached conidia. (× 1000.)

Fig. 8. Habit sketch of branching conidiophore, arising from rope-like mass of hyphae. (× 300.)

PLATE 17

Aspergillus luchuensis Inui

Fig. 1. Echinulate spores. (× 2000.)

Fig. 2. Vesicle, showing arrangement of sterigmata and spores. (× 500.)

Fig. 3. Swollen mycelium with chlamydospores. (× 500.)

Aspergillus fumigatus Fres.

Fig. 4. Vesicle with attached sterigmata. (× 400.)

Fig. 5. Columnar spore bodies. (× 150.)

Fig. 6. Portion of conidial chain. (× 1000.)

Myrothecium convexum Berk. & Curt.

Fig. 7. Portion of vegetative mycelium. (× 1000.)

Fig. 8. Sporodochia, each with margin of sinuous cilia. (× 150.)

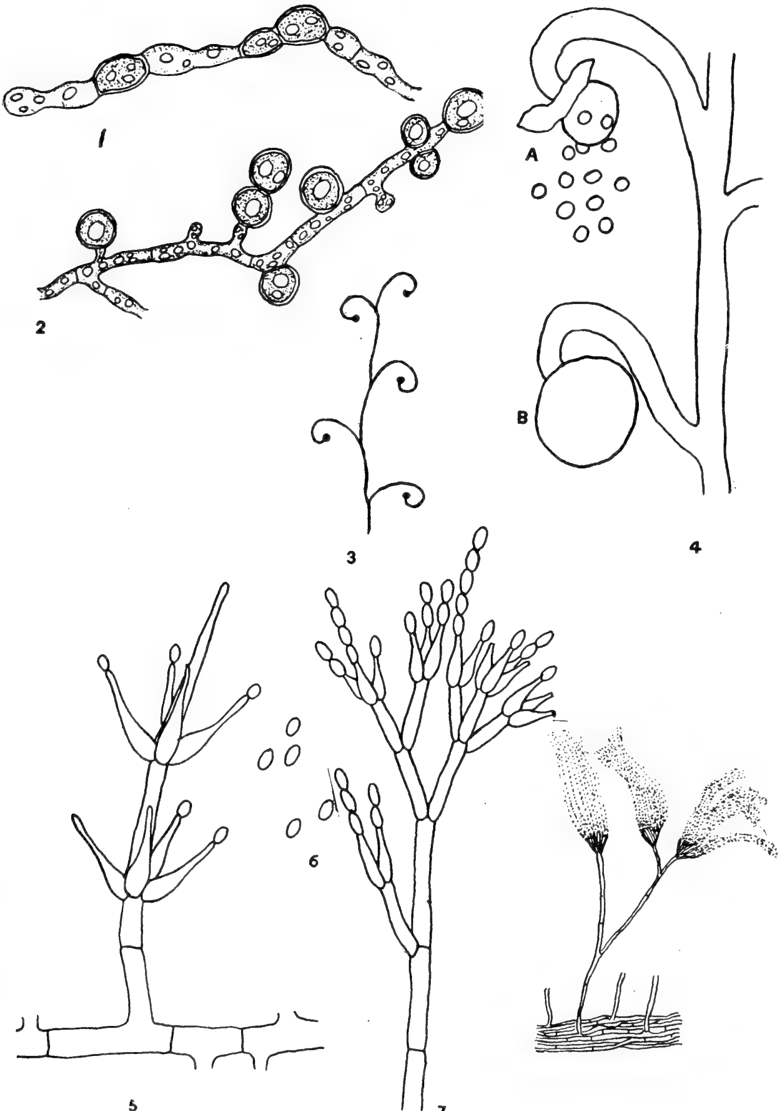
Fig. 9. Warty, branched conidiophore. (× 1000.)

Fig. 10. Fusiform spores. (× 1000.)

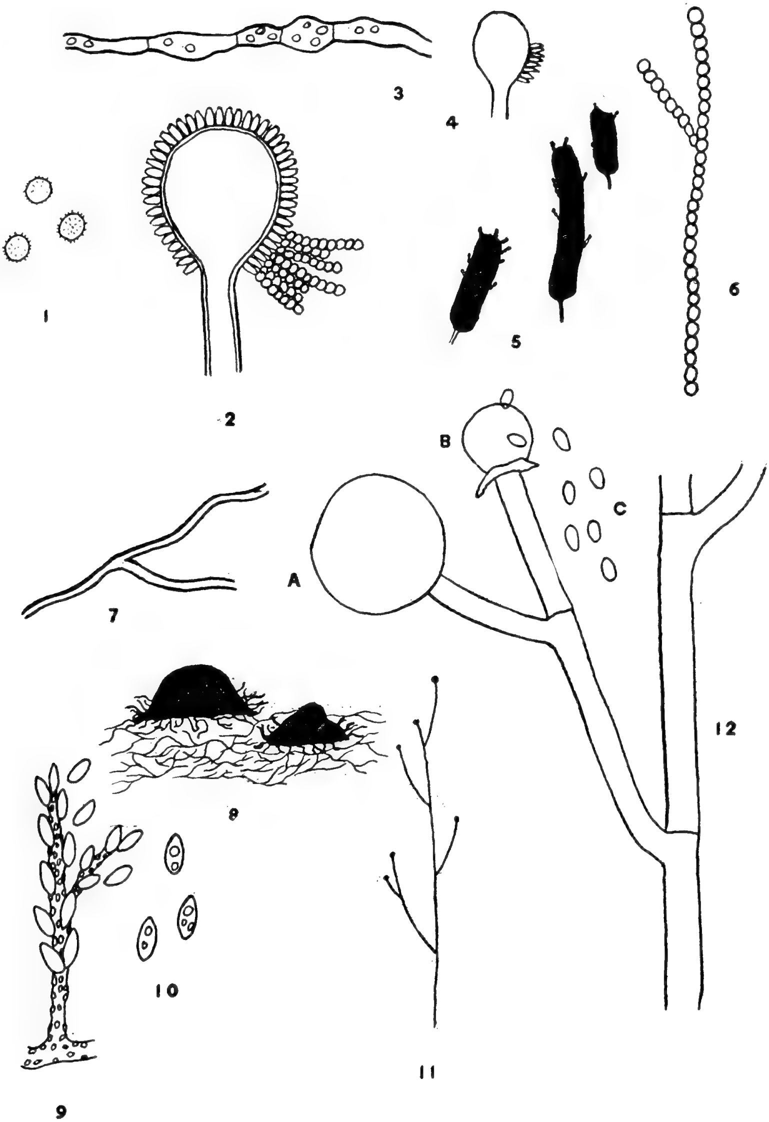
Mucor griseo-lilacinus Povah

Fig. 11. Habit sketch of conidiophore, showing manner of branching. (× 20.)

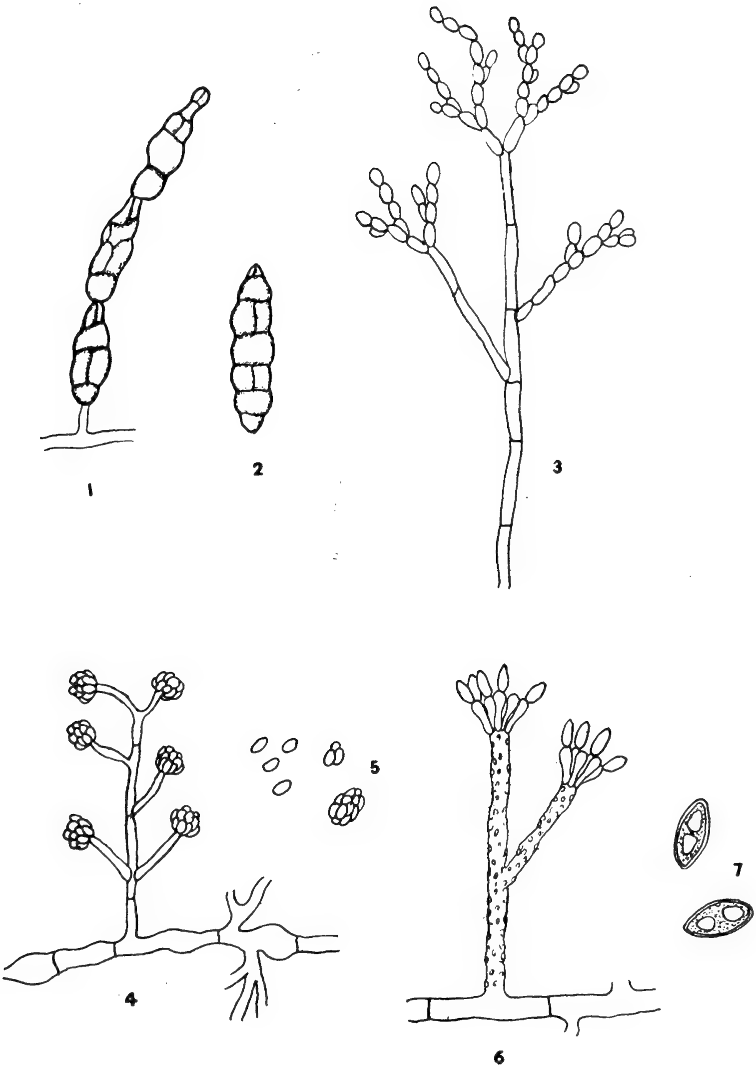
Fig. 12. Detail of sporangiophore. *A*. Sporangium. (× 375.) *B*. Columella with basal collar. (× 375.) *C*. Spores. (× 800.)



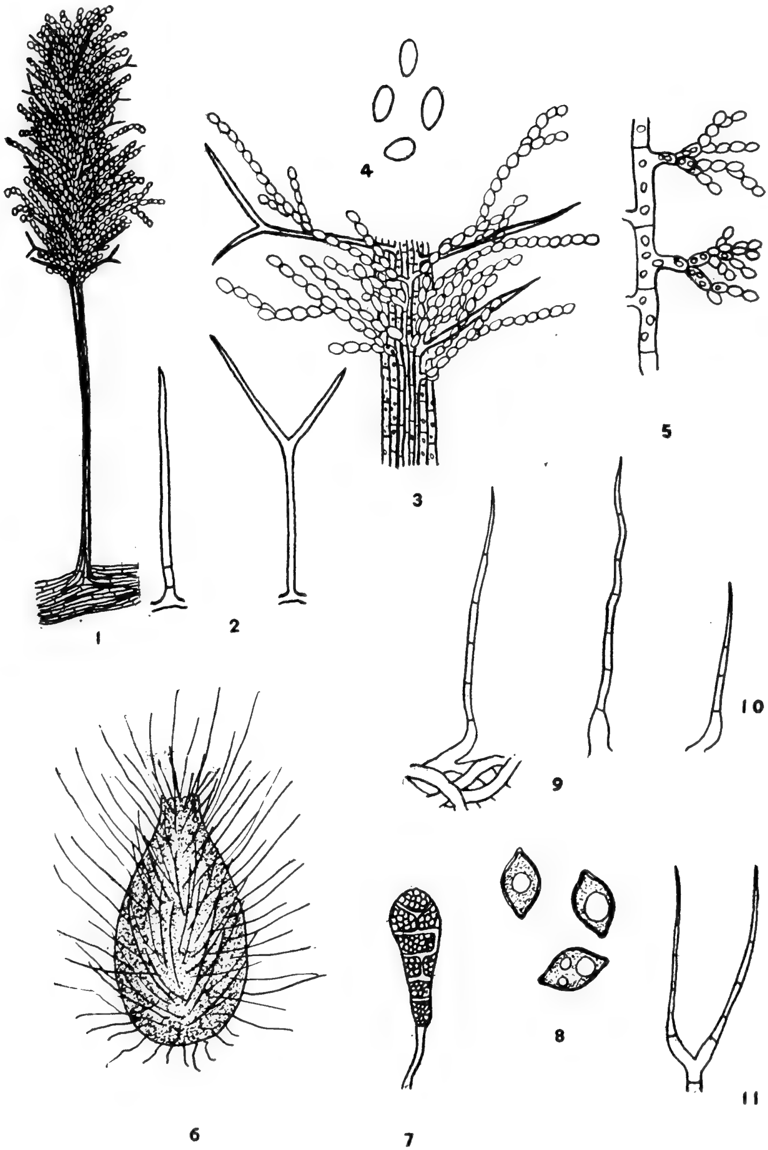
Soil Fungi of Illinois



SOIL FUNGI OF ILLINOIS



Soil Fungi of Illinois



Soil Fungi of Illinois

PLATE 18

Alternaria humicola Oud.

Fig. 1. Chain of spores on short conidiophore. (× 1000.)
Fig. 2. Single muriform spore. (× 1000.)

Hormodendrum cladosporioides Fres.

Fig. 3. Detail of conidiophore, showing manner of branching, with attached catenulate conidia. (× 1000.)

Trichoderma Koningi Oud.

Fig. 4. Branched conidiophore, bearing spherical conidial heads. (×1000.)
Fig. 5. Detached conidia, single and in groups. (× 1000.)

Stachybotrys atra Corda

Fig. 6. Warty, branched condiophore, showing whorl of sterigmata with attached spores. (× 1000.)
Fig. 7. Fusiform spores with large oil globules. (× 1500.)

PLATE 19

Trichurus terrophilus Swift & Povah, sp. nov.

Fig. 1. Conidial body rising from rope-like aggregation of mycelium, showing slender stalk and fertile portion bearing catenulate conidia and simple and forked setae. (× 250.)
Fig. 2. Details of simple and forked setae. (× 1000.)
Fig. 3. Lower portion of fertile part of fruit body, showing chains of spores emerging laterally from closely associated hyphae. (× 500.)
Fig. 4. Spores. (× 2000.)
Fig. 5. Young hypha, showing early stage in spore development. (×1000.)

Chaetomium subterraneum Swift & Povah, sp. nov.

Fig. 6. Ovoid perithecium, showing uniform distribution of simple, straight, lateral and terminal hairs, with shorter setae immediately surrounding ostiole. (× 250.)
Fig. 7. Immature ascus containing young spores. (× 500.)
Fig. 8. Lemon-shaped spores. (× 1500.)
Fig. 9. Straight seta, showing interlacing hyphae of perithecial wall, and slightly undulate seta with bulbous swelling at base. (× 500.)
Fig. 10. Short seta from ostiole region of perithecium, showing bulbous base and elbow-turn. (× 500.)
Fig. 11. One of the occasional branched setae from lower portion of perithecium. (× 500.)

THE NATURE OF GIANT SPORES AND SEGREGATION OF SEX FACTORS IN NEUROSPORA

B. O. Dodge

The occasional production of unisexual spores in asci of *Neurospora tetrasperma*, which is normally four-spored but occasionally may produce five or six spores in a single ascus, is fortunate, as it enables one to cross this homothallic species with the heterothallic species of the genus. Unisexual haplonts of *N. tetrasperma* may be secured in two different ways. First,

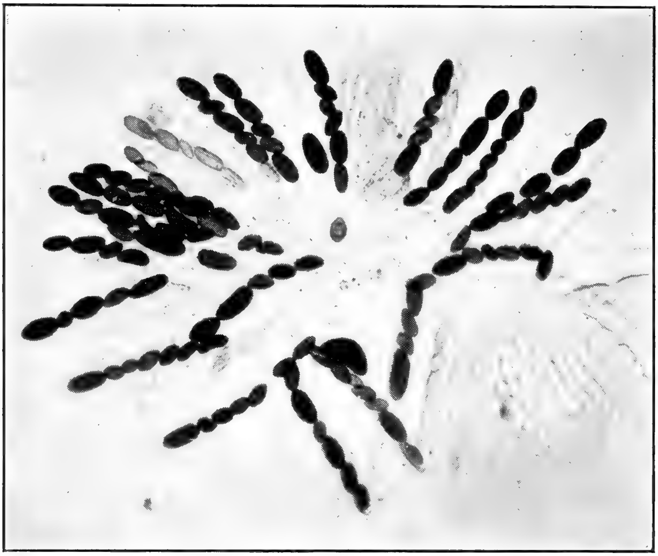


Fig. 1. Asci from a hybrid perithecium obtained by back-crossing an f_1 hybrid (*Neurospora sitophila* × *N. tetrasperma*) with the *tetrasperma* parent. No abortion of ascospores apparent. Large ascospores probably contain several nuclei. × 190.

one can select the very small ascospores which give rise to unisexual mycelia. Such haplonts can be propagated indefinitely asexually either by transplanting cuttings of their mycelia or by

sowing their conidia which are, after all, for purposes of propagation, nothing but small cuttings. Unisexual haplonts may also be secured if the conidia from normal bisexual mycelia are plated out and selected on the basis of the length of time required for their germination. Choosing those conidia whose germination was the longest delayed, one obtains 10 to 25% unisexual mycelia. Regardless of which way the unisexual haplonts are obtained normal perithecia will develop when haplonts of opposite sex are mated in culture. The ascospores will be predominantly bisexual as usual.

Certain back-crosses in the series started by crossing *N. sitophila* and *N. tetrasperma* tend to produce one or two very large spores in some of the asci.[1] One or more smaller spores may develop along with a single giant spore (FIG. 1). The largest spores may have as many as four nuclei of each sex when they are cut out. The ascus then would be 1-spored. The inclusion of more than one nucleus in an ascospore at its delimitation is characteristic of the *N. tetrasperma* parent. Over-sized spores are formed occasionally by the parent species, *N. tetrasperma* (FIG. 2, x), but in such cases the big spores are the same genotypically as any other spore except that the very small spores are unisexual.

In quite another category genetically are the giant spores of hybrids. The fact that some asci in a back-cross produce giant spores while some other ascus in the same perithecium may contain eight uninucleate spores, is an expression of *tetrasperma* as contrasted with *sitophila* inheritance. The ascus being a mother cell, whatever segregations occur here would be represented by different types of nuclei which result from the three successive nuclear divisions. When all eight nuclei happen to be included in a single giant spore which can be grown into a new plant, the complexity of its composition genetically is such as to require careful analysis if its total inheritance is to be ascertained. With each mycelial cell containing several nuclei which may differ genotypically there is not likely to be an equal distribution of all of the elements of inheritance to different hyphal branches.

[1] Dodge, B. O., The Production of Fertile Hybrids in the Ascomycete *Neurospora*, Jour. Agr. Research, **36**: 1–14, 1928.

Since the ascogenous cells are also multinucleate there are bound to be all sorts of matings of nuclei in the various asci of the same fruit body.

Why breed from a complex giant spore when it is simpler to start with the small uninucleate spores? These back-cross asci rarely develop eight spores, and even when they do there are the hazards to be met in their separation and germination. Furthermore a study of the progeny of the eight separate spores in an ascus would not tell us anything about the peculiarities of the giant spores as such.

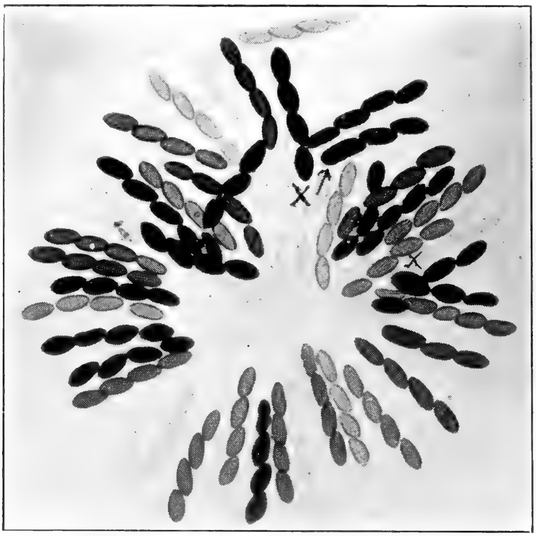


FIG. 2. Asci from a perithecium of *Neurospora tetrasperma*. At "x" asci with three spores, one spore over-sized in each case. × 190

There is a way out of the difficulty. The method is equivalent to cutting up the giant spore into its components and then growing each part independently in pure culture. The inheritance carried by each nucleus could thus be studied by itself and in any combination desired. The procedure would simply be to grow a mycelium from the giant hybrid ascospore and plate out the uninucleate unisexual conidia in the way noted previously.[2] Just how many distinct types of haplonts could be

[2] Dodge, B. O., Unisexual Conidia from Bisexual Mycelia, MYCOLOGIA, **20**: 226–234, 1928.

isolated would depend on the nature of the sexual processes involved in the production of the ascocarp. Of course there would be two kinds of mycelia as regards their sex. Provided the factors are not sex-linked we would get also different types of haplonts with regard to other characters, the number depending on just what had been the nuclear behavior previously in the life cycle. Perhaps we have here something which will eventually throw light on the question as to the nature of sexual reproduction in the ascomycetes as distinct from nuclear fusions in the ascus. Stout [3] has recently discussed the clon in the fungi in his treatment of clons in the higher plants.

The mycelium obtained by germinating a giant hybrid ascospore would also produce a great many multinucleate conidia. The type of clon obtained from a multinucleate conidium must therefore depend on which nuclei happen to have been thrown together in that conidium. There could, therefore, be selected out just as many different types of clons as there would be possible combinations of the genotypically different nuclei contained within the original ascospore. The complications met with in connection with giant hybrid ascospores would not enter into a study of crosses between *N. sitophila* and *N. crassa* because in both species the ascospores are normally uninucleate and unisexual at their origin.

This brings us up to the point where the rare or occasional giant spore is developed in asci of the heterothallic species, *N. crassa*. It has been assumed that since the large spores of *N. tetrasperma* are bisexual while the little ones are unisexual, the same line of reasoning should hold for the abnormal spores of *N. crassa*. Its normal ascospores, which are about 31 μ long, are unisexual. Its giant spores, 60 to 90 μ long, should then be bisexual and give rise to homothallic instead of unisexual haplonts. The determination of the sexual nature of these giant ascospores by culture work shows that this line of reasoning does not hold. Moreover it has been found that segregation of the sex factors in *N. crassa* must take place in the first nuclear division in the ascus. The distribution of the spores as regards their

[3] Stout, A. B., The Clon in Plant Life, Jour. N. Y. Bot. Gard., **30**: 25–37, 1929.

sex does not agree with the report by Marguerite Wilcox [4] for *N. sitophila*, a species in many respects very similar to *N. crassa*.

GIANT SPORES OF *Neurospora crassa*

As noted previously one finds occasionally a very large ascospore in a spore print of *N. crassa*. A crushed mount may also show a 4-spored ascus (FIG. 3, RIGHT). These 4-spored asci are such perfect pictures of normal asci of *N. tetrasperma* (FIG. 2) that one would expect the spores would also be bisexual. Hoping

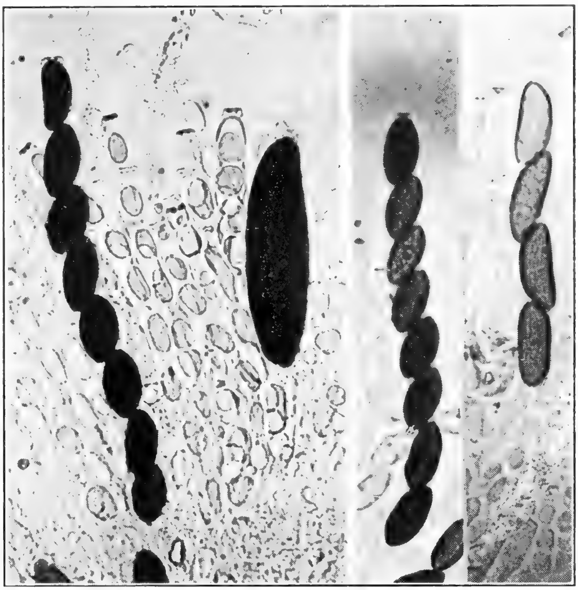


FIG. 3. Asci from a perithecium of *Neurospora crassa*. At the center a giant spore and to the left a normal ascus for comparison. The two asci at the right are from the same perithecium. The 4-spored ascus resembles a normal ascus of *N. tetrasperma*. × 300.

to obtain a homothallic mycelium from a giant spore such as is shown in figure 3, several large spores were isolated and germinated. Cultures were obtained from spores 41, 49, 50, 51, 58, 64 and 85 microns in length. After the germ tubes from each end of a spore had branched out sufficiently the tip ends were cut off

[4] Wilcox, M. S., The Sexuality and Arrangement of the Spores in the Ascus of *Neurospora sitophila*, MYCOLOGIA, **20**: 3–16, 1928.

and transplanted. Several cultures from each spore were obtained in this way. This method was used to avoid possible contamination from conidia which must occasionally be carried over with the ascospore.

It was certainly expected that the mycelium from the largest spores would prove to be homothallic and develop perithecia. Such was not the case, as all the cultures remained sterile. On the theory that the nuclei of opposite sex might have been distributed to different hyphal branches, all of the mycelia derived from the same ascospore were grown together in pairs in all possible combinations. For example, 13 separate cultures had been obtained from the largest spore, which was 85 μ long. None of the combination cultures produced perithecia. It is clear that the mycelia obtained from these particular spores at least were all unisexual. This suggested that perhaps the segregation of the sex factors in *N. crassa* might occur during the first of the three nuclear divisions in the ascus, so that the four nuclei in one end would all be alike sexually. Unless a giant spore in one end of the ascus included more than four nuclei at its origin it would be unisexual.

Culture work to determine just where segregation takes place was begun by germinating normal ascospores. Meanwhile further study of crushed mounts showed that in *N. crassa* oversized spores are very frequently present in asci showing abortion of other spores. In this case a giant spore may include only one nucleus at its origin but grow disproportionately because of food made available by abortion of adjacent spores. But such 4-spored asci as are shown in figure 3 do not present evidence of spore abortion. If the spindles of the third division in the ascus are oriented as they are in *N. sitophila*,[4] each of the four spores might include two sister nuclei. This would account for their size and unisexual nature. There is still the possibility of nuclear degeneration without spore formation as described by Harper.[5] This point was discussed briefly by the writer in another connection.[6] A cytological study of the ascus of *N. crassa* will be neces-

[5] Harper, R. A., Kerntheilung und freie Zellbildung im Ascus, Jahrb. Wiss. Bot., **30**: 249–284, 1897.

[6] Dodge, B. O., Formation of Spores in Asci with Fewer than Eight Spores, MYCOLOGIA, **22**: 8–21, 1928.

sary to determine the question of nuclear degeneration raised here.

SEGREGATION OF THE SEX FACTORS IN 8-SPORED ASCI IN *N. crassa*

Mature ascospores from several normal asci were isolated one by one and their positions in the ascus were noted. After germination each spore was transferred directly to a tube of corn meal agar. As no perithecia developed in these single ascospore cultures it was clear that no conidia of opposite sex had been carried over in any case with the transfer of the ascospore. Cultures were obtained in this way from all eight spores in each of three different asci. In each case the eight haplonts were grown together in pairs in all possible combinations. The results obtained by growing the three sets of haplonts as noted all agreed. The checkerboard diagram of these results is shown in Table 1.

TABLE 1

RESULTS OBTAINED BY GROWING IN ALL POSSIBLE COMBINATIONS EIGHT HAPLONTS REPRESENTING THE EIGHT ASCOSPORES FROM AN ASCUS OF *N. crassa*

Spores are numbered in order of their position in the ascus. The sign + indicates that perithecia were produced; the sign − negative results.

	1	2	3	4	5	6	7	8
1	−	−	−	−	+	+	+	+
2	−	−	−	−	+	+	+	+
3	−	−	−	−	+	+	+	+
4	−	−	−	−	+	+	+	+
5	+	+	+	+	−	−	−	−
6	+	+	+	+	−	−	−	−
7	+	+	+	+	−	−	−	−
8	+	+	+	+	−	−	−	−

The table shows that no perithecia were produced in culture when haplonts nos. 1, 2, 3 and 4 were grown separately or together in any combination; the same is true for haplonts nos. 5, 6, 7 and 8. But when any one of the first four haplonts is grown with any one of the second four, perithecia are produced. This proves

conclusively that the four spores in one end of the ascus were of the same sex.

The results were further checked by isolating the spores from three other asci. But here no attempt was made to record the exact position of the spore except that in each case the four spores from one end of the ascus were first carefully isolated from the four in the other end, after which the spores in each group were separated and germinated. In one case only 3 spores from each end of the ascus germinated. This was sufficient for the purpose however. If segregation had occurred in the second division, one of the three spores would differ in sex from the other two. Either three or four spores from one end of each of ten other asci were also isolated and grown in culture. In each of the thirteen sets noted the mycelia were grown in pairs in various combinations and in addition the mycelia representing the four spores in the one end of the ascus were all grown together in one culture. This last procedure, after all, furnishes the very best of evidence that all four spores are alike sexually. If they were not alike, perithecia would surely have developed. The results of the work represented by several hundred cultures go to prove conclusively that in *N. crassa* segregation of the sex factors occurs in the first nuclear division in the ascus.

SEGREGATION OF SEX FACTORS IN *N. sitophila*

Wilcox, working with *N. sitophila*, concludes that segregation of the sex factors in that species must occur in the second nuclear division in the ascus. She reaches this conclusion on the basis of the orientation of the spindle figures presented during the three divisions, taken in connection with the results of her culture work. She reports, as noted previously, that the spores alternate in pairs in the ascus, two of one sex and two of the other.

Judging from what is said to occur in species of *Coprinus* it would not be strange to find two species of the same genus of ascomycetes differing with respect to the particular nuclear division during which segregation takes place. The asci in *N. crassa* and *N. sitophila* are much alike, being long and slender, and their eight spores are regularly uniseriate. No doubt the spindles of the three divisions have much the same orientation. The ques-

tion arises as to whether they really differ so markedly as to the disposition of their spores of opposite sex.

The eight spores in an ascus of *N. sitophila* were carefully isolated and the positions which they had occupied in the ascus were noted. The spores were germinated and two complete sets of cultures in duplicate were obtained. After three or four days the cultures in both sets showed striking differences in the color and quantity of conidia produced. Cultures nos. 1, 2 and 5, 6 showed very pale fluffy aerial hyphae with no conidia. Cultures nos. 3, 4 and 7, 8 showed masses of bright orange-colored conidia. Clearly here was an alternation in pairs which suggested that the mycelia would also alternate in pairs as to their sex. The eight haplonts were then grown together in pairs in all possible combinations. As a further check haplonts nos. 1, 2, 3 and 4 were all grown together in one culture, as were haplonts nos. 5, 6, 7 and 8. The results show clearly that, whatever may be the meaning of the definite alternation in pairs viewed from the standpoint of production and color of conidia, it has no significance as regards the sex of the ascospores in this ascus. Spores nos. 1, 2, 3 and 4 proved to be all alike and opposite in sex to spores nos. 5, 6, 7 and 8. A checkerboard diagram showing results of the culture work would be the same as that given for *N. crassa* in Table 1.

It is then interesting to prove that segregation of the factors determining the type of conidia produced by a mycelium of *N. sitophila* occurs in the second division in the ascus, while the factors for sex are segregated in the first division. Cultures made to determine whether distinct races can be obtained by mating haplonts nos. 1 and 5 as contrasted with the results obtained by mating haplonts nos. 3 and 7 give very positive and striking results.

Further work proves that in *N. sitophila* the spores may sometimes also alternate in pairs as to their sex as reported by Wilcox. In the case of *N. tetrasperma* each of the four spores in the ascus is bisexual because it includes at its origin one nucleus of each sex. Ascospores of *N. crassa* and *N. sitophila* are unisexual and only a single nucleus is included in a spore when it is cut out. In the first species the four spores in one end of an ascus are all of the same sex and they are of the opposite sex to

the four spores in the other end of the same ascus. In *N. sitophila* the segregation of the sex factors may occur in either the first or second division. A full account of the work on developing new strains of *N. sitophila* which are practically sterile so far as conidia are concerned will be published later.

THE NEW YORK BOTANICAL GARDEN

NOTES AND BRIEF ARTICLES

In my article in Mycologia, March–April number, 1929, page 98, "A" under legend for Figure 1 appears "Ascospores," which should read "Basidiospores."—S. M. Zeller.

Professor A. H. R. Buller of the University of Winnipeg, Canada, an Associate Editor of Mycologia, has recently been elected Fellow in the Royal Society of London.

The New York Botanical Garden has recently added to its already large rust collection about eight hundred specimens of German Uredineae distributed by Theodor Oswald Weigel of Germany.

The Editor of this publication is planning to spend two months during the summer in the Rocky Mountains near Denver continuing his field studies on the Cup-fungi preparatory to publishing a volume on the inoperculate forms which will be a companion volume to the one just issued on the Operculates. So much interest has been manifest in this work that the project is being pushed with renewed interest.

The Herbarium and Library of the late Dr. Bruce Fink has been acquired by the University Herbarium of the University of Michigan. His collection of Lichens especially has great scientific value because of its being the source material on which the forthcoming book of Dr. Fink's "Lichens of the United States" has been based. The material will be transferred from Miami University in June and will be accessible to scientists within a few months thereafter.—C. H. Kauffman.

THE IMPERFECT STAGE OF *Crytosphaeria populina* [1]

Perithecia of *Crytosphaeria populina* (Pers.) Sacc. growing on a dead branch of the Balm of Gilead Poplar, were brought into the laboratory during Oct. 1928. Pieces of the dead bark containing perithecia were laid on wet blotting paper in a petri dish. A small amount of nutrient agar was poured on the inside of the petri dish cover, and when this had solidified the cover was placed on the dish with the agar about one cm. above the bark.

In a few days the allantoid, one-celled ascospores were found in dense masses on the agar. They germinated immediately and several transfers were made from the germinated spore masses to nutrient agar in culture tubes. While these were not single spore cultures there appeared to be no contaminations in the petri dishes at the time the transfers were made.

Within from two to four weeks pycnidia were formed in the tube cultures. Orange-yellow spore masses were pushed out of these pycnidia, in some cases forming tendrils entirely similar to those formed by species of *Cytospora*.

Examination of the spores showed that they belong to the genus *Cytosporina*. The spores were hyaline, filiform, sickle-shaped, some varying to hook-shaped, and averaged $20\,\mu \times 1\,\mu$. The length was measured across the longest axis of curvature of the spore, and varied from $15\,\mu$ to $30\,\mu$, depending on the degree of curvature.

After these results had been obtained, the writer found that Wehmeyer had also grown *Cryptosphaeria populina* in culture. In his paper in the American Journal of Botany (**13**: 1926), in a footnote at the bottom of page 592, he mentions the occurrence of pycnidia with spores such as described above, in cultures of *Crytosphaeria populina* on sterilized poplar twigs.

E. J. SCHREINER

[1] Abstract of a report presented to the Conference of the Scientific Staff and Registered Students of the New York Botanical Garden on March 13, 1928.

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MYCOLOGIA

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Dasyscypha Agassizii

MYCOLOGIA

VOL. XXI SEPTEMBER–OCTOBER, 1929 NO. 4

DASYSCYPHA AGASSIZII ON PINUS STROBUS

WALTER H. SNELL

(WITH PLATE 20)

In connection with damage studies of the white pine blister rust in the Adirondacks for the past few years (**4**, **5**), the writer has been obtaining incidental data of various sorts for possible future use. For example, certain observations have been made on the secondary fungi on the blister rust cankers (**5**). The original interest was in the possibility of a certain amount of biological control of the blister rust and in other epidemiological relations.

The fungi commonly found upon the dead areas of the blister rust cankers are a species of *Phoma* (imperfect stage of *Caliciopsis pinea* Peck) and *Cenangium Abietis* (Pers.) Rehm. *Stereum sanguinolentum* Alb. & Schw. is found only rarely on the cankers, not so often as it is found on dead parts not infected by *Cronartium ribicola*. In the summer of 1927, another fungus was found to be quite common on the cankers in a white pine plantation that was being studied near Dannemora. It was identified for the writer as *Dasyscypha Agassizii* (Berk. & Curt.) Sacc.[1] (**5**).

At the time of this discovery, it was thought that this fungus occurred only on *Abies*, as stated by Saccardo (**3**), and that the identity of other hosts might be subject to question. In view of the uncertainty as to the occurrence of *Dasyscypha Agassizii* on *Picea*, a thorough search was made at the Dannemora plantation, where balsam fir and red spruce grow in close proximity to

[1] The fungus was first sent to Dr. E. A. Burt through an error, and later to Dr. F. J. Seaver. Both identified it as noted.

[MYCOLOGIA for July–August (**21**: 175–233) was issued July 1, 1929.]

the planted pines, under what are apparently very favorable conditions for the fructification of this fungus. It was found in large quantities on the fir, upon which in some cases areas as large as two square feet were thickly covered with large apothecia. After a prolonged examination of fallen and standing red spruce, fructifications were found on two branches of a fallen tree that were very close to an infected balsam trunk and well protected by debris to provide very moist conditions. The fruit bodies were few and small, but were in good condition. A few old fruit bodies were likewise found.

Following this success, nearby planted *Pinus sylvestris* was examined. On one shaded-out branch were found three old apothecia that appeared to be very similar to the old ones found upon spruce just previously, but their condition was such that a definite determination was impossible. No claim can therefore be made.

An examination of a few herbaria in 1927 showed records of the occurrence of *Dasyscypha Agassizii* on several hosts, including those named above. Most of the collections in the New York Botanical Garden are upon *Abies*, with a few upon *Picea*, *Pinus monticola* and a pine presumably *Pinus Strobus*. All but two of the specimens in the Farlow Herbarium at Harvard are upon *Abies balsamea*. One of these was noted in Farlow's handwriting as "on hemlock" (*Tsuga canadensis*). The other exception is one of the Curtis Herbarium specimens on *Abies Fraseri* from Black Mountain or the Black Mountains ("*Mont. Nigr.*" in Curtis' hand), North Carolina. On the packet, however, is also written "*Peziza crocea* ex Berk." (cf. **1**, p. 160). Saccardo accepts this latter view of the identity of the specimen (**3**, p. 261), listing the collection as *Phialea* (*Peziza*) *crocea* (Schw.) Sacc. Examination of the specimen shows that this disposition of the fungus is probably somewhat nearer the truth than calling it *Dasyscypha Agassizii*, on account of the smoothness of the apothecium and the small size of the spores ($5–6 \times 2.5–3\ \mu$).

The collections of this fungus made by Dr. L. O. Overholts are all on *Abies balsamea*, as are those in the herbarium of Dr. C. W. Dodge at Harvard.

The specimen in the Brown University Herbarium is on

Abies balsamea (from the Curtis collection). There is another specimen labelled *D. Agassizii* on *Abies lasiocarpa* (Fungi Columbiani no. *4530*), collected at Silver Lake, Colorado. This determination is incorrect, however, inasmuch as the hairs on the outside of the apothecium are dark colored instead of hyaline.

The largest number of collections of this fungus, made for the most part in 1927 and 1928, is in the herbarium of the Office of Investigations in Forest Pathology, United States Department of Agriculture. Through the kindness of Dr. Perley Spaulding, these specimens were sent to the writer for examination and even the most recently acquired data were provided for use in this paper. The specimens are upon *Abies balsamea*, *Pinus Strobus*, *Pinus monticola* and *Picea mariana*. There are also two upon *Pseudotsuga taxifolia*, but the writer is not certain that the species is *D. Agassizii*. The apothecia have a somewhat different appearance and spores have not been found by the writer.

The usual host of *Dasyscypha Agassizii* appears, therefore, to be *Abies balsamea*, but it is apparent that it may occur occasionally on other Gymnosperms. It seems to occur more often upon white pine than upon any other host except balsam fir. It was found in considerable abundance at Dannemora, New York, in 1927 as a secondary fungus on blister rust cankers and also to a lesser extent on white pine bark not infected by *Cronartium ribicola*. On this plantation, 103, or about 10 per cent, of the blister rust cankers were invaded by secondary fungi, and upon 78 of these 103 *D. Agassizii* was fruiting abundantly (see PLATE 20). Search was made for this fungus on white pine elsewhere in 1927, but it was found only in the writer's Kelm Mountain plot near Warrensburg, New York, and not so abundantly there.

In 1928, however, further search revealed it in very small amounts on the following experimental plots in New York: Horicon at Horicon; Burdick near Warrensburg; Harkness, Downes and McCormick near Keeseville; Sternberg near Central Bridge. It was found in great abundance again at Dannemora. One dead pine branch 1 inch in diameter was covered all over for a distance of 20 inches with small and medium-sized fruit

bodies. On another young pine in this plantation, from which a piece of bark with fruit bodies had been removed in 1927, apothecia were found growing out of the exposed sapwood.

In connection with this matter of the hosts of *Dasyscypha Agassizii*, there is one point of interest. Berkeley, in the original announcement of the species (1) as *Peziza* (*Humaria*) *Agassizii* Berk. & Curt. collected by Agassiz near Lake Superior (Calumet as noted by Curtis), makes no reference to a specific host, but notes simply—"on bark." Saccardo, as noted above, makes the host *Abies*. In Curtis' handwriting on the packet containing the co-type specimen in the Farlow Herbarium are these words —"in cort. Pini?" The other specimen mentioned by Berkeley as collected by Oakes in New England (White Mountains according to Curtis on the packet) is on *Abies balsamea*. It is difficult to discern whether the host bark of the former (the co-type) specimen is white pine or balsam fir, but in view of the foregoing discussion it would be odd if the host of the type specimen happened to be white pine instead of fir.

It seems strange that this fungus has not been seen before on white pine. Many workers, including the writer, have been poring over blister rust cankers for years and several have paid more than passing attention to the secondary fungi on those cankers. It is more than possible that it has been passed by as some other fungus, as for instance a stipitate *Stereum*. Most blister rust workers, in common with phytopathologists in general, have no interest in the wood-inhabiting Hymenomycetes and no knowledge of them whatsoever. But even if there were some interest, it would be easy to ignore this *Dasyscypha* as some other form, more especially when it is dried and shriveled and in small numbers. In fact, the writer, engrossed in his other work, ignored it as a "*Stereum*" at first, until it was noted moist and expanded a day or two later and examined at leisure in the field office. But the writer does not recollect seeing anything like it before in several years of contact with white pine.

It does not seem that moisture could be a determining factor in its invasion of white pine. The fruit bodies of *D. Agassizii* were found, to be sure, only down low on the 12-year-old trees, well protected by foliage, and the summer of 1927 was an un-

usually moist one, especially in the northern Adirondacks during June and July. But there have been other moist summers before now. It was thought at first that latitude might be a determining factor, as the fungus was found not far from the Canadian line (at about latitude 44° 45′) and at an altitude of 2,100 feet. The fungus was located later in 1927, however, at Kelm Mountain near Warrensburg (about latitude 43° 33′), at an altitude of 1,200 feet. It may be, of course, that this *Dasyscypha* can attack white pine only in its northern limits, if these isolated instances can be taken to have any significance.

As a matter of fact, the range of the fungus appears to be limited for the most part to sub-boreal habitats. Berkeley (**1**) and Saccardo (**3**, p. 438) record collections of this fungus from Lake Superior and New England (Calumet and White Mountains respectively, according to Curtis). The specimens in the New York Botanical Garden Herbarium are from Newfoundland, New Brunswick, Ontario, Maine, New Hampshire, New York, Pennsylvania (collected by Overholts), Michigan, and Wisconsin. There are also specimens labelled *D. Agassizii* from Colorado and from Montana. The former is no. *4530* of the Fungi Columbiani, the same as the specimen in Brown University Herbarium and is not this species. The specimen upon *Pinus contorta* from Montana is not *D. Agassizii*, for it has spherical spores (perhaps a *Lachnellula*). The Farlow Herbarium contains the two collections mentioned by Berkeley and Saccardo, the doubtful one from North Carolina and one from the Adirondacks in New York (all in the Curtis Herbarium), and other collections from Newfoundland, northern Maine, the White Mountains in New Hampshire, northern Vermont, and a very questionable one from Iowa. This latter specimen is upon an angiospermous host (probably rosaceous), and is apparently some other *Dasyscypha*. Dodge's collections are from the Gaspé peninsula in Quebec. The Curtis specimen in the Brown University Herbarium is from the White Mountains. The specimens in the collections of the Office of Investigations in Forest Pathology are from Newfoundland, northern New York, northern and southern New Hampshire (Mount Washington to Keene), northern Vermont, Montana, Idaho, and Ipswich, Massachusetts.

Most of Overholts' collections are from near Mount Washington, New Hampshire, with one from Pennsylvania.

Most of these specimens are from north of 43° 30′ latitude, and many of them from points at some distance above sea level. The stations for those from southern New Hampshire and Massachusetts are at about latitude 42° 40′ to 42° 50′. The Iowa collection can be excluded from consideration on the ground of its identity. The North Carolina specimen can also probably be excluded, although if it should be found to be *D. Agassizii*, the altitude of its station might compensate for its southern latitude (about 35° 35′). According as we interpret Curtis' Latin as the town of "Black Mountain" or as the "Black Mountains," the altitude would be between 2,000 and 5,000 feet respectively and, as such, not so far out of its normal range. Outside of the foregoing, the Pennsylvania specimens are the only ones from very far south of this line. The Pennsylvania specimens are from a point about 41° north latitude and about 1,000 feet above sea level. The stations for the Pennsylvania and southern New Hampshire and Massachusetts collections apparently represent the southernmost limits of the distribution of *Dasyscypha Agassizii*, and are south of the sub-boreal zone. Except for these collections, it appears that this fungus is typically sub-boreal in its habitat, as stated above.

According to Saccardo (**3**) the ascospores of *Dasyscypha Agassizii* measure 6.5–7.5 × 4 μ. Berkeley (**1**) originally gave the size as ".0002 long" (a little over 5 μ). On one packet in the Farlow Herbarium, the size of the spores from a specimen on *Abies* is given as 5.7–7.5 × 3.8 μ, while another is given by Farlow with a question mark as 7.5 × 2.5 μ. The spores from the writer's specimens on fir were found to be 6–9 × 3–4.2 μ, most of them 7–8.5 × 3.5 μ, with occasional ones up to 10.5 × 5.25 μ. The spores from white pine were found to be somewhat more slender than the accepted sizes, as noted by Seaver in his original determination, measuring 6–9 × 3–3.5 μ, with most of them 7–8.5 μ long. Spores from specimens on spruce were 6.5–7.5 × 3–3.5 μ. The asci are 70–95 × 5.5 μ.

Cankered bark with *Dasyscypha Agassizii* was sectioned, stained with the Pianeze stain, and examined for the mycelium.

The mycelium takes the light green stain well and can be found readily enough near the apothecia, but it is not abundant or striking. Beneath and very near the bases of the apothecia, some cells are quite solidly filled with the fine, much branched hyphae. A few cells away, there may be three or four branching hyphae in a cell now and then, and beyond that point, a single filament crossing a cell here and there. Hyphae have thus far been found 15 or 20 cells in from the outside, but not at all in the innermost bark. The hyphae must penetrate more deeply than has been discovered thus far, however, because, as noted above, fruit bodies were found in 1928 upon exposed sapwood from which bark bearing this fungus had been removed in 1927.

The hyphae are very fine, measuring about .5–1.2 μ or occasionally 1.5 μ in diameter. No cross walls and no other detail could be made out in the stained hyphae. Branching is quite abundant and is mostly at nearly right angles, the branches often being considerably broadened at the point of departure from the original hypha. The mycelium has a cobwebby appearance in the empty cells. As far as could be determined, the hyphae are somewhat constricted in the passage through the host cell walls.

There were a few hyphae of larger diameter in the sections and these were probably hyphae of *Cronartium ribicola*. It is needless to point out that there is no danger of confusing the hyphae of *Dasyscypha Agassizii* and *Cronartium ribicola* (**2**). Further, it seems likely that the two fungi will not often be found in the same tissues, either because of the relative scarcity of the ascomycete or because of the different conditions under which the two vegetate.

For courtesies extended in examination of herbarium material, in furnishing information by correspondence, or in allowing the use of data upon collections, the writer wishes to express his gratitude to the following: Dr. H. H. York of the New York Conservation Department, Dr. F. J. Seaver of the New York Botanical Garden, Dr. Perley Spaulding of the Office of Investigations of Forest Pathology (Northeast Forest Experiment Station at Amherst), Dr. C. W. Dodge of the Farlow Herbarium, and Dr. L. O. Overholts of Pennsylvania State College.

SUMMARY

Dasyscypha Agassizii (Berk. & Curt.) Sacc. was found to be very abundant upon planted *Pinus Strobus*, especially on blister rust cankers, and to occur also on several pine lots studied.

This fungus has been known in literature only upon *Abies balsamea*. This host is found to be the usual one for the fungus, but collections are here noted also upon *Tsuga canadensis, Pinus monticola, Picea rubra, Picea mariana*, and possibly *Pseudotsuga taxifolia* as well as *Pinus Strobus*.

The habitat of *Dasyscypha Agassizii* is apparently sub-boreal. The herbarium specimens available were from north of 43° 30′ north latitude for the most part (excluding two doubtful forms), the exceptions being from Pennsylvania at 1,000 feet, and from Massachusetts and southern New Hampshire.

The ascospores of material upon white pine and spruce were found to be somewhat more slender than given by Saccardo.

A description of the mycelium in blister rust cankered white pine bark is given.

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PROVIDENCE, RHODE ISLAND

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PLATE 20

Fruit bodies of *Dasyscypha Agassizii* (Berk. & Curt.) Sacc. on a blister rust canker on *Pinus Strobus*, Dannemora, N. Y. Photograph taken during moist weather. About natural size.

NOTE. Since the preparation of this manuscript, Mr. A. B. Seymour has called to the writer's attention the presence of another collection in the Farlow Herbarium, which for unknown reasons was overlooked on previous inspections. This collection is on *Pinus Strobus* from Maine on September 15, 1923. This, therefore, antedates the writer's finding of this fungus on White Pine.

THE TAXONOMY OF PEZIZA QUERNEA

Wm. W. Diehl and Edith K. Cash

(With Plate 21 and 2 Text Figures)

Peziza quernea Schw. has been gathered but rarely since the original collection and any interpretation of its structure and taxonomy has been prevented largely by a lack of specimens. Available material, moreover, has not been in satisfactory condition for adequate study. A specimen from Lakoochee, Florida, in exceptionally good condition, shows certain characteristic features which are of taxonomic significance.

The fungus appears to be distinct from *Cenangium*, to which the species has heretofore been referred, in the presence of an epithecium and of conspicuous excipular ridges which persist as claw-like projections on the margin of the opened disk. This ridged exciple resembles that of *Godronia*,[1] but the fungus differs in the thicker, more carbonaceous texture, in the simple ascospores and in the subapplanate form when mature. Among the genera of the Patellariaceae it is most suggestive of *Starbaeckia*, which, however, lacks the regular excipular ridges and possesses much branched paraphyses. Since its most obvious relationships are with *Cenangium* and *Godronia*, the species *Peziza quernea* is retained in the Cenangiaceae and is taken as the type of a new genus.

GODRONIOPSIS, n. gen.

Apothecia sessile or subsessile, seated upon a black stromatoid base, at first closed, subspherical, later cup-shaped to patellate, corky-leathery to subcarbonous when dry; exciple with prominent vertical ridges from the margin to the base; asci opening by a

[1] *Godronia* Moug. (Consid. génér. végét. spont. Dépt. Vosges, p. 355, 1845) as typified by *G. Muhlenbeckii* Moug. & Lév. Even though Rehm (Ascomyceten, p. 240–241, 1896) places this species in his subgenus or section *Muhlenbeckia* rather than in *Eugodronia*, any discussion of or comparison with the genus *Godronia* must depend upon this type species. *G. Muhlenbeckii* is characterized by the furrowed and also ridged exciple, urceolate apothecium, linear, pluriseptate ascospores, and simple, filiform paraphyses.

pore, 8-spored, iodine-; spores simple, hyaline; paraphyses septate, simple to branched, somewhat inflated toward the apices, forming an epithecium.

Godroniopsis quernea (Schw.) n. comb.

Syn. *Peziza quernea* Schw. Syn. Fung. Carol. Sup. no. 1265 in Schr. Nat. Ges. Leipzig **1**: 124, 1822.[2]

Cenangium turgidum Fries in Syst. Myc. **2**: 186, 1822. (Not *C. turgidum* Duby, 1830.)

Cenangium turgidum Schw. Syn. Fung. Amer. Bor. no. 1995 in Trans. Amer. Phil. Soc. (Philadelphia) II, **4**: 238, 1832.

Patellaria cenangiicola Ellis & Ev. Jour. Myc. **4**: 56, 1888.

Patellea cenangicola Ellis & Ev. sec. Sacc. in Syll. Fung. **8**: 784, 1889.

Cenangium querneum (Schw.) Seym. sec. Thaxter in Mycologia **14**: 101, 1922.[3]

Apothecia separate but closely crowded, seated upon a scurfy, black, pseudoparenchymatous to prosenchymatous stromatoid layer covering well-defined hypertrophied areas up to 1 cm. in diameter, larger by confluence, sessile, at first subglobose, cupulate to subapplanate when expanded, up to 1 mm. in diameter; exciple chestnut-brown to blackish, subrugose, corky-leathery to subcarbonous when dry, somewhat fleshy-leathery when moist, concentrically sulcate with ridges connivent at the mouth, later with tips of ridges persisting as claw-like projections incurved from the margin; hymenium even, brown; asci clavate to cylindrical-clavate, 77–150 × 13–16 μ, usually about 90 × 15 μ, opening by a pore, iodine-, with 8 spores irregularly biseriate; spores simple (rarely becoming pseudoseptate), hyaline, subfusiform to fusiform, at first asymmetrical and slightly larger at

[2] Although there has been some doubt in regard to the exact date of this publication in its relation to that of Fries' Systema, the evidence presented by Shear and Stevens (Mycologia **9**: 197, 1917) is rather conclusive as to the appearance of the Schweinitz publication early in 1822 but not previously, since Schweinitz was first apprized of it on receipt of reprints late in 1822. The citation in Fries' Systema, Volume 2, of many Schweinitzian names as synonyms suggests the priority of the Schweinitz publication.

[3] This citation refers to No. 106 of Reliquiae Farlowianae labeled *Cenangium turgidum* (Schw.) Fries, which is not that species but is *Excipula* (sub *Cenangium*) *turgida* Fries, Syst. Myc. **2**: 189 = *Cenangium turgidum* (Fries) Duby = *Catinula turgida* (Fries) Desm.

one end, 30–47 × 6–10 μ, becoming narrower and more symmetrical at maturity; paraphyses filiform and hyaline at the base, septate, simple to branching toward the apices, apex light

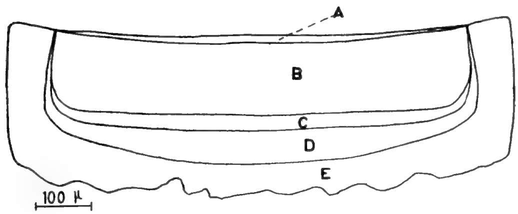


FIG. 1. Diagram of vertical section through an apothecium to show tissue relations. A. Epithecium; B. Hymenium; C. Hypothecium; D. Medullary layer of exciple; E. Ectal layer of exciple.

to dark chestnut-brown, inflated, subclavate, reaching a diameter of 3–5.5 μ, gelatinizing to form an epithecium; hypothecium in vertical section subhyaline to brownish, as a loose prosenchyma about 30 μ thick; exciple about 90–150 μ thick, in two layers: (1) medullary layer a definite, subhyaline to light brown pseudo-

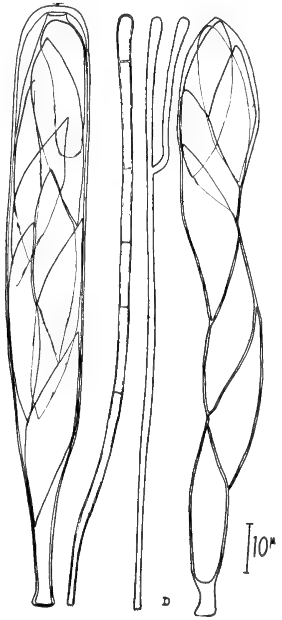


FIG. 2. Asci and paraphyses. (For the branched paraphysis and the ascus on the right the protoplasmic membrane was not clearly defined.)

parenchyma of polygonal cells 3–5 μ in diameter, in mass appearing as a palisade separated from the hypothecium by a border of darker cells; (2) ectal layer of tissue similar to the medullary layer, but denser and more opaque in section with outer border irregularly lacerate.

On small twigs of various species of *Quercus* in the Eastern United States.

SPECIMENS EXAMINED

On *Quercus* sp., either Salem, N. C., or Bethlehem, Pa.[4], as *Cenangium turgidum* in Herb. Schweinitz and in Herb. Michener.—Specimens not in good condition but showing the characteristic incurved projections of the exciple.

On *Quercus* sp., Missouri, comm. Winter, as *Cenangium turgidum* in Herb. N. Y. Bot. Gard.

On *Q. alba*, Newfield, N. J., Dec., 1879, with specimen of *Dichaena* in Ellis & Ev. N. Am. Fungi *793*, in Herb. N. Y. Bot. Gard.

On *Q. coccinea*, Alabama, coll. Peters, as *Cenangium turgidum* in Rav. Car. **4**: 24.

On *Q. coccinea*, Newfield, N. J., Apr., 1888, as *Cenangium turgidum* in Ellis & Ev. N. Am. Fungi *2148*.

On *Q. coccinea*, Newfield, N. J., Apr. 30, 1888, type of *Patellaria cenangiicola* Ellis & Ev., in Herb. N. Y. Bot. Gard.

On *Q. marilandica*, Lakoochee, Fla., 1900–1902, L. H. McCullough.

On *Q. tinctoria*, Newfield, N. J., Apr., 1874, J. B. Ellis, as *Cenangium turgidum* in Herb. N. Y. Bot. Gard.

On *Q. virginiana*, Dunedin, Fla., Apr. 20, 1900, S. M. Tracy 6619, as *Dichaena* in U. S. Nat. Herb. and in Herb. N. Y. Bot. Gard.—No spores found.

Except where otherwise noted these specimens are in the Mycological Collections, B. P. I. Several specimens labeled

[4] Both the Schweinitz specimens cited are mere fragments although the Michener Herbarium specimen is labeled merely "Bethlehem." If the Philadelphia specimen is not a duplicate it may then be considered as from Salem, in which case it would be looked upon as the type. It is, of course, possible that Schweinitz sent the original material to Fries or to others as was his custom.

Dichaena appear to be *Godroniopsis*, at least in part, but are in too poor condition for positive determination.

Of the specimens cited the one from Lakoochee, Florida, shows the most robust development and is more indicative of a normal condition than is the type specimen. The ectal ridges of the exciple are persistent in unopened or open disks, both of which, when viewed from above, present a stellate appearance with these ectal ridges as stellar apices on the periphery. In widely opened disks these ridge-tips persist as horn-like or claw-like projections, often incurved from the margin of the apothecium (see plate). The general aspect of the fungus closely resembles that of *Dichaena quercina* (Pers.) Fries except for a rougher appearance and its occurrence only upon conspicuous swollen areas of the twigs. These somewhat pulvinate or effuse swollen areas are hypertrophies limited to the cork layer of the bark and composed of cork cells with hyphal elements. Although nothing is known of the exact relationship between the fungus and these hypertrophies, they are associated in all the specimens examined.

Examination of type material of *Patellaria cenangiicola* Ellis & Ev., described as occurring on *Cenangium turgidum*, failed to show any fungus except the latter. While most of these apothecia are identical with typical opened disks of *Godroniopsis*, with characteristic points of the excipular ridges conspicuous on the margin, a few are present in which the exciple has practically disappeared, leaving mere fragments on the lower surface. *Patellaria cenangiicola* was apparently described from material in this latter condition. No spores were found to be definitely septate as noted in the description, although protoplasmic separation occasionally produced a pseudoseptate appearance. In all other characters, the type material of the *Patellaria* agrees completely with specimens of *Godroniopsis quernea*.

Thanks are due to Drs. C. W. Dodge, F. W. Pennell, and F. J. Seaver for the privilege of examining certain specimens.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

EXPLANATION OF PLATE 21

Fig. 1. Florida specimen (L. H. McCullough), × 2.2, showing habit.

Fig. 2. Detail of Fig. 1, × 10, showing closed apothecia.

Fig. 3. S. Car. specimen (Ravenel Fungi Car. **4**: no. *24*), × 25, showing open apothecia.

Fig. 4. S. Car. specimen (Ravenel Fungi Car. **4**: no. *24*), photomicrograph of vertical section through apothecium, × 143.

Photographic negatives for Figs. 1, 2, and 4 by M. L. S. Foubert, for Fig. 3 by J. F. Brewer.

Godroniopsis quernea

THE YELLOW SPECIES OF ACAROSPORA IN NORTH AMERICA

(Descriptions of new species and key)

By A. H. Magnusson

Key to the yellow species known from North America

1*a*. Thallus with more or less distinct marginal lobes.
  2*a*. Apothecia 0.1–0.3 mm. broad.
    3*a*. Hymenium about 100 μ high, cortex 15–25 μ thick . . . . . . *A. extenuata.*
    3*b*. Hymenium about 65–70 μ high, cortex 35–50 μ . . . . *A. texana.*
  2*b*. Apothecia usually above 0.5 mm. broad.
    4*a*. Apothecia prominent, usually convex with disappearing margin, hymenium about 50 μ high . . . . . *A. chlorophana.*[1]
    4*b*. Apothecia in thallus—level with persistent margin, plane, hymenium 60–90 μ high . . . . . . *A. oxytona.*
1*b*. Thallus areolate or squamulose.
  5*a*. Apothecia dilatate, 0.5 mm. broad or larger.
    6*a*. Growing on earth, apothecia reddish brown, spores globose . . . . . . *A. Schleicheri.*
    6*b*. Growing on stone, spores ellipsoid.
      7*a*. Hymenium below 120 μ high, apothecia immersed, brownish red, cortex about 50 μ.
        8*a*. Areolae more or less dark citrine, contiguous, apothecial margin prominent . . . . *A. socialis.*
        8*b*. Areolae pale citrine or whitish, dispersed, apothecial margin not prominent . . . . *A. subalbida.*
      7*b*. Hymenium 120–135 μ high, medulla filled with granules, apothecia 1–1.5 mm., prominent . . . . . . *A. evoluta.*
  5*b*. Apothecia punctiform or rarely surpassing 0.5 mm.
    9*a*. Hymenium above 120 μ high.
      10*a*. Lower side blackish, squamules 2–7 mm. broad.
        11*a*. Cortical lumina distinct, 3–4 μ, medullary hyphae leptodermatous, apothecia several, pale; spores $4–6 \times 2.5–3$ μ . . . . . . *A. Brouardi.*
        11*b*. Cortical lumina indistinct, medullary hyphae pachydermatous, apothecia poorly developed, spores narrow . . . . *A. xanthophana.*
      10*b*. Lower side pale, cortical lumina 2–2.5 μ, apothecia punctiform, pale . . . . . . *A. Amabilis.*

[1] Not yet recorded from North America.

9b. Hymenium below 120 μ.
12a. Spores broadly ellipsoid or subglobose, 2–3 μ broad.
13a. Apothecia inconspicuous, pale; squamules dispersed, hymenium 75–85 μ, cortical lumina 1.5–2 μ . . . . *A. samcënsis.*
13b. Apothecia 0.2–0.5 mm., blackish brown, several; areolae contiguous; hymenium 85–100 μ, cortical lumina 3–6 μ . . . . *A. bella.*
12b. Spores narrowly ellipsoid, 1.5–2 μ broad.
14a. Cortex 55–75 μ thick, apothecia 0.4–0.6 mm., brownish red, areolae whitish, paraphyses firmly coherent . . . . *A. subalbida.*
14b. Cortex below 50 μ thick, apothecia blackish.
15a. Apothecia punctiform, thallus continuous, smooth, more or less viteline, areolae not gomphate . . . . *A. contigua.*
15b. Apothecia dilatate, areolae more or less gomphate, their center often whitish, lower side dark brown . . . . . *A. chrysops.*

DESCRIPTIONS OF NEW SPECIES

1. **Acarospora texana** H. Magn. n. sp.

Thallus intense flavus, determinatus, ambitu plus minusve distinctus radiatus vel lobulato-crenatus, centroversus areolatus, arcte adnatus, subtus pallidus. Apothecia sparsa, solitaria, primum punctiformia, deinde plus minusve dilatata, minuta, discus concavus fuscocarneus. Hymenium angustum. Sporae tenuiter ellipsoideae.

Thallus (in the small specimen seen) forming areas 0.5–1 cm. in diameter, as a rule distinctly limited, pale yellow, the marginal areolae 1 mm. long, more or less distinctly lobate, 0.5–0.75 mm. broad, plane or slightly convex, opaque, smooth, about 0.2 mm. thick, the central areolae contiguous, angulose, separated by thin cracks, 0.3–0.4 mm. thick, the fertile ones more or less slightly verrucose, all unaltered by KOH and $CaCl_2O_2$, largely affixed, the lower surface pale.

Cortex 35–50 μ thick, in water yellowish gray, not transparent, in KOH colorless with an outer amorphous stratum, 20–25 μ, and an inner stratum, darker in the upper half, with perpendicular, indistinct hyphae and poorly visible lumina, about 1 μ in diameter. Gonidia 7–12 μ thick, forming an unbroken stratum 50 μ thick, with an even upper surface and somewhat distinct lower limit. Medulla 100–300 μ thick, in water dirty gray, opaque on account of innumerable very small granules covering

the hyphae and dissolving in HCl. Then the hyphae appear to be arachnoidly intricate, 3.5–4.5 μ thick, very pachydermatous, with uneven, seemingly rough surface and very thin, more or less filiform lumina. Lower cortex partly well developed, resembling the upper one.

Apothecia present only in the central areolae but not numerous, at first punctiform, always impressed, disc round, 0.1–0.25 mm. broad, pale yellowish brown, concave, smooth. Exciple distinct, 8–12 μ, colorless, not fanlike at the surface. Hypothecium 20–30 μ, densely intricate. Hymenium 65–70 μ, like the hypothecium colored dark blue with iodine, lower half colorless, upper 25–35 μ dark yellow with uneven surface or dirty brownish red. Paraphyses coherent, not discrete in water, somewhat free in KOH, 1.7–2 μ thick, not capitate, midmost joints scarcely visible, 5–7 μ. Asci 40–50 × 16–19 μ, swollen clavate or pyriform. Spores about one hundred, 3–4.5 × 1.5–1.8 μ, ellipsoid.

Pycnidia not observed.

On granitic, quartz-resembling stone.

U. S. A. Texas; "in mont. Texanis, *E. T[uckerman]*" sub *Parmelia chlorophana*, type (in Botanical Garden, Uppsala) perhaps belonging to Wright's collection cited in Tuckerman, Syn. N. Am. Lich. **1**: 201. 1882.[2]

A. texana looks like a young specimen of *A. chlorophana* or *A. oxytona* but it is distinctly separated by the constantly immersed, very small apothecia. It resembles *A. oxytona* in having an opaque medulla but is separated by a narrower exciple and cortex. From the European *A. hilaris* (Duf.) Hue, which it resembles in habit, it is distinguished by the very indistinct cortical lumina and the smaller spores.

2. **Acarospora extenuata** H. Magn. n. sp.

Thallus determinatus, pallide virescenti-citrinus, tenuis, centro areolatus, ambitu plus minusve distincte lobatus, lobuli substrato arcte adpressi, plani, rimis tenuibus separati, subtus pallidi. Apothecia pauca, minutissima, punctiformia, singula vel raro duo triave in quavis areola, discus leviter impressus, fuscus. Cortex tenuis. Hymenium angustum. Sporae tenuiter ellipsoideae.

[2] A careful comparison of a single collection of *Parmelia chlorophana* from Texas in Tuckerman's Herb. labeled "Organ Mountains, Texas, Wright 1852" with the above description leaves no doubt that the specimen belongs to *A. texana* and is probably a portion of the type collection.—C. W. Dodge.

Thallus more or less distinctly determinate, forming more or less continuous areas up to at least 3 cm. broad, pale greenish citrine, marginal lobes 1–2 mm. long, 0.5–1 mm. broad, widened at the apices, toward the circumference very thin, smooth, plane, separated by very narrow cracks, the center areolate with partly loosening areolae, these 0.5–1 mm. broad, 0.3–0.4 mm. thick, of different shape, separated by thin cracks, plane or slightly convex, smooth, unaltered by KOH and $CaCl_2O_2$, widely fastened to the stone with the pale lower surface.

Cortex very thin, 15–25 μ, in water, KOH and HCl pale yellowish brown, opaque, in $CaCl_2O_2$ pale dirty yellow with indistinct lumina 1.5–2.5 μ in diameter. Gonidia 10–14 μ in a stratum 50–100 μ thick, continuous also below hymenium, surface rather even. Medulla 100–200 μ thick, transparent or dirty yellowish, obscured by particles from the substratum, not dissolving in HCl. Hyphae mainly perpendicular or more or less intricate, 2–3 μ thick, leptodermatous, closely woven. The pale marginal cortex sometimes extending far in under the areolae and resembling the upper one, but the areolae widely affixed.

Apothecia not numerous, solitary or rarely two or three in each areola, immersed, disc punctiform, 0.1–0.2 mm. broad, more or less brownish or yellowish brown, scarcely visible. No distinct exciple. Hypothecium thin, 25–35 μ, grumose. Hymenium 100–115 μ high, colorless, in iodine red, upper 25–35 μ dark dirty yellow, surface very uneven, often with a yellowish amorphous stratum up to 35 μ thick. Paraphyses in water fairly discrete, 1.8–2 μ, slightly swollen at the apices. Asci 80–90 × 25 μ, swollen clavate. Spores at least 200, (3.5–)4–5.5 × 1.7–1.9 μ, mostly narrowly ellipsoid.

Pycnidia not found.

On granitic rocks.

Mexico, vicinity of Mexico City, *Frère Amable 604*, type (in herb. B. de Lesdain).

A. extenuata seems to be nearly related to *A. hilaris* (Duf.) Hue but has a thinner cortex with indistinct lumina, the hymenium is higher and the asci swollen.

3. **Acarospora socialis** H. Magn. n. sp.

Thallus indeterminatus areolatus, saturate vel virescenti-flavus, areolae minutae, dispersae vel plus minusve contiguae, irregulares, convexae, subtus obscurae. Apothecia maculatim congregata, in quavis areola saepius solitaria, discus sensim

dilatatus, ad 1 mm. latus, obscure rufus, planus. Cortex superior crassus luminibus distinctis. Hymenium subangustum. Sporae tenuiter ellipsoideae.

Thallus indeterminate, covering areas up to at least 4 cm. (or probably much larger), of a bright or greenish yellow color, areolate, unaltered by KOH and $CaCl_2O_2$. Areolae approaching one another or ± contiguous with narrow cracks, usually angular or irregular, occasionally even sublobate, of unequal size, 0.3–1(–1.5) mm. broad, 0.3–0.5(–0.8) mm. thick, smooth, convex, with appressed or rarely rising margins, distinctly gomphate with the lower side usually dark brown.

Cortex 40–70(–85) μ thick, near the margins only 35 μ, uppermost 20–35 μ greenish yellow, somewhat transparent, reticulate, amorphous stratum up to 5 μ. In water lumina distinct, also in the colored part, more or less round and leptodermatous, 2.5–3.5 μ in diameter, in HCl very distinct. Gonidia 7–14 μ, in a dense continuous stratum, 200 μ thick (100 μ below the hymenium) with even upper surface. Medulla usually transparent, mostly less than 300 μ thick. Hyphae somewhat loosely intricate or partly contiguous, distinctly leptodermatous, lumina more or less cylindric, 6–7 × 2 μ or globose, 2–4 μ in diameter. Upper cortex gradually passing into the lower one, which is of the same texture and thickness or thinner, but the exterior 12–17 μ dark brown far in under the areola, or partly pale.

Apothecia in some parts of the thallus crowded, in others absent, one, or occasionally 2–4, in each areola, at first punctiform, soon dilated, immersed, disc dark brownish red, round or somewhat irregular, (0.3–)0.5–1(–1.5) mm. broad, smooth and plane, surrounded by the prominent margin of the areola. Exciple very distinct, below 15–35 μ thick, at the surface 50–110 μ, in iodine not colored or pale blue, with very distinct leptodermatous lumina, below globose, 2–3 μ, towards the surface elongate, 3–5 × 2–3 μ, surface dark greenish yellow. Hypothecium varying, 30–120 μ, yellowish, in iodine dark blue. Hymenium 90–120 μ, colorless, in iodine bluish or dark dirty green, uppermost 10–17 μ reddish brown in water. Paraphyses in water coherent, more or less discernible, 1.7–2(–2.5) μ thick, the apices in KOH coherent, not or only slightly capitate, 3 μ, brownish yellow. Asci numerous, 60–85 × 14–17 μ, elongate. Spores 100–200, 4–5.5 × 1.8 μ, narrowly ellipsoid.

Pycnidia numerous, one or several in the sterile areolae, visible as small blackish dots, slightly prominent above the thallus surface, about 0.1–0.2 mm. broad, globose, with sometimes infolded wall. Sterigmata 8–10 μ, conidia 2–2.5 × 0.6–0.9 μ, ellipsoid.

On granitic stone, in most specimens associated with species of *Caloplaca* and *Lecanora* (cf. *L. saxicola*), thus indicating a habitat rich in nitrogen.

U. S. A. California: Fresno County, Kings River, *G. Eisen* (in Botanical Garden at Uppsala); Santa Cruz County, Santa Cruz Mountains, foothills 1½ miles from Mayfield, *Herre*, 1904 (Nat. Hist. Mus. Wien); Los Angeles County, Santa Catalina Island, on mountain tops, *L. W. Nuttall 478*, type (in Merrill Herb. at Farlow Herb.); San Diego County, San Diego, *Clara Cummings*, 1896, in Cummings, Williams and Seymour, Decades of North American Lichens *215*, under *Lecanora xanthophana* (in British Museum).

MEXICO: Querétaro at 1850 m., *Arsène Brouard*, 1914 (in Herb. B. de Lesdain).

CHILE: Santiago, Serro de Ranca, P. Dusén, 1896 (in Herb. G. O. Malme).

A. socialis belongs to the small group with large apothecia and comes near *A. evoluta*. As to the differences between these two species, see below. In one specimen I have found a chalky white medulla with a non-granular material not dissolving in HCl but in KOH.

4. **Acarospora evoluta** H. Magn. n. sp.

Thallus areolatus, virescenti-luteus vel obscure citrinus, areolae contiguae, crassae, inaequales, saepe sublobatae, margine libero, subtus pallidae. Apothecia sparsa, magna, thallum paullo superantia, discus planus, rotundus, carneo-fuscescens, scabridus. Cortex crassus, distincte cellulosus. Hymenium altum. Sporae tenuiter ellipsoideae.

Thallus somewhat dark greenish yellow, probably indeterminate (margin not observed), areolae squamuliform, contiguous, confluent, 1–3 mm. broad, 0.7–1.5 mm. thick, opaque, on the whole plane or slightly convex though very uneven and ± verruculose from numerous pycnidia, unaltered by KOH and $CaCl_2O_2$, the margins often free, especially in the ± panniform areolae. Lower side pale, areolae usually distinctly gomphate.

Cortex very uneven in thickness, in one specimen 35–50 μ, in another 70–90 or even 170 μ, upper third or two fifths dark yellow, hardly transparent, lower part white with netlike arranged, very distinct lumina, 3–4 μ, ± round, no distinct amorphous stratum. Gonidia 8–12 μ, in a very irregular stratum,

50–200 μ thick, interrupted by pycnidia or hyphal strands, sometimes in vertically stretched, $\pm$ rectangular lumps. Medulla dirty white, obscured by innumerable white granules, dissolving in KOH, hyphae then arachnoid, irregularly swollen, 3–4 μ thick, $\pm$ pachydermatous.

Apothecia scanty, in or among the areolae, slightly rising above thallus level, disc 1–1.4 mm. broad, plane, rough from yellow remains of the cortex, pale reddish brown or yellowish brown with a distinct, prominent margin.

Exciple distinct, about 20 μ thick, at the surface 80–100 μ. Hypothecium 50–70 μ. Hymenium (110–)120–135 μ, colorless, in iodine pale or greenish blue, uppermost 25–30 μ dark yellow. Paraphyses very discrete, 1.6–1.8 μ, leptodermatous, not distinctly capitate but uppermost joints short, ellipsoid, 2–2.5 μ. Asci 90–100 $\times$ 16–17 μ, clavate. Spores 100–200, 5–6 $\times$ 1.8–2 μ, narrowly ellipsoid.

Pycnidia sometimes numerous, immersed, with pale mouth, reaching 200 μ in depth and 150–180 μ in breadth with very irregular, infolded and pale wall. Sterigmata about 10 μ, conidia 2–2.5 $\times$ 0.8–1 μ, narrowly ellipsoid.

On granitic or volcanic rocks, with traces of a *Caloplaca*-species.

U. S. A. California: Santa Barbara, Cooper's Canon, *W. G. Farlow* (Journey to Calif. 1885) (Nat. Hist. Mus. Wien and Farlow Herb.); Santa Cruz Mts., Mayfield, *Kingman*, 1916 (in hb. C. C. Plitt), type.

A. evoluta is distinguished from the other yellowish species especially by the large apothecia with a distinct margin and the thick, uneven areolae. It may be compared with *A. socialis*, which also has large apothecia, but this one has thinner, smooth areolae dark below, blackish mouth of the pycnidia, and a low hymenium with coherent paraphyses.

5. **Acarospora Amabilis** H. Magn. n. sp.

Thallus indeterminatus, areolatus, areolae citrinae, saepius contiguae, minutae, subplanae, subtus pallidae. Apothecia rara, immersa, punctiformia, discus thallo concolor, rotundus vel elongatus. Cortex superior crassus, distincte cellulosus. Hymenium altum. Sporae tenuiter ellipsoideae.

Thallus indeterminate, areolate, citrine-yellow, areolae 0.6–1 mm. large, 0.3–0.4 mm. thick, usually contiguous and separated by distinct cracks, or towards the circumference dispersed, angulose, single areolae even sublobate, mostly plane or slightly

uneven, unaltered by KOH and $CaCl_2O_2$, somewhat widely affixed with pale lower surface.

Cortex 40–60(–85) μ thick, upper half dark yellow, not transparent, lower white, amorphous stratum indistinct. Lumina 2–2.5(–3) μ, rather distinct in water. Surface very uneven, sometimes with small pits. Gonidia 7–13 μ, in a 70–100 μ thick, unbroken stratum. Medulla thin, 50–100 μ, colorless and transparent, often with inspersed gonidia, hyphae intricate, distinctly leptodermatous, 2.5–3.5 μ thick with short ± round or irregular lumina. Lower side pale, rarely with a dark yellow cortex, only 5–10 μ thick.

Apothecia not numerous, immersed, inconspicuous, single or often several in each areola, disc punctiform or more or less elongated and irregular, 0.1–0.2(–0.3) mm. broad, concolorous with the thallus. Exciple indistinct. Hypothecium about 50 μ high, more or less conical, in iodine blue. Hymenium 135–170 μ high, in iodine pale blue or pale yellowish red, uppermost 20–30 μ in water dark yellow. Paraphyses distinct though coherent, 1.8–2 μ thick, in water with visible filiform lumina, the apices not capitate, also in KOH yellow. Asci 90–100 × 15–25 μ, clavate, young. Spores 100–200, 5–7.5 × 1.6–1.9 μ, narrowly ellipsoid or subcylindric.

On lax, grayish yellow, farinose not calciferous stone associated with *Caloplaca*-species.

MEXICO: Tlalpan near the city of Mexico, 1926, *Frère Amable* (comm. B. de Lesdain).

A. Amabilis resembles other yellow species in appearance but is distinguished by the small apothecia with high hymenium and narrow spores, the thick cortex and the leptodermatous medullary hyphae.

In the single specimen seen I noticed that the upper cortex, especially the lower uncolored part of it, assumed a distinct reddish yellow color in iodine. This uncommon feature is perhaps accidental.

6. **Acarospora contigua** H. Magn. n. sp.

Thallus indeterminatus, areolatus, areolae pallide vitellinae, contiguae, minutae, planae arcte et late adnatae. Apothecia numerosa, in quavis areola singula, dua triave, punctiformia, obscura. Lumina corticis distincta, hymenium angustum. Sporae tenuiter ellipsoideae.

Thallus indeterminate, crustose, continuous for at least 2–3

cm., dark almost vitelline yellow, on the whole smooth, areolae 0.3–0.5(–1) mm. broad, towards the circumference very thin, in the center thicker, 0.3(–0.4) mm. and sometimes loosening, irregularly angulose, separated by very thin cracks, plane, smooth, fastened to the stone with the whole lower surface.

Cortex 35–50 μ, upper half or two thirds dark greenish yellow, opaque, lower part transparent, amorphous stratum indistinct. Lumina distinct in water, especially in the lower part, 2.5–3.5(–4) μ broad, angulose, leptodermatous. Gonidia 8–14 μ, stratum very lax, with indistinct upper and lower limit, 50–80 μ thick, with dense traversing hyphae or groups of hyphae. The medullary stratum not distinctly limited, consisting of loosely intricate, thread-like, 2–3 μ thick hyphae and $\pm$ cellulose parts with round, 2.5–4 μ broad, leptodermatous lumina, the whole with numerous particles from the substratum. No lower cortex.

Apothecia numerous, especially towards the center, immersed, punctiform, solitary or occasionally 2–3 in each areola, disc 0.1–0.2(–0.3) mm., blackish, on a level with the thalline surface or slightly immersed.

Exciple below more or less distinct, 6–12 μ thick, yellowish. Hypothecium 50–70 μ, shallowly cup-like, grumose, in iodine dark blue. Hymenium 90–100 μ, in iodine dirty reddish, uppermost 16–20 μ $\pm$ dark yellow. Paraphyses rather discrete, 1.7 μ thick, in HCl after pressure quite free or the apices conglutinate, not capitate but slightly swollen, 2.5–3 μ in KOH. Asci 60–65 $\times$ 17–19 μ, broadly clavate. Spores 100–200, 4–5 $\times$ 1.6–1.9 μ, ellipsoid.

On a somewhat calciferous sandstone-like rock.

U. S. A. Texas (no locality given), *I. Boll* (Nat. Hist. Mus. Wien, Stockholm and Farlow Herb.), associated with *A. chrysops* Tuck Lesd. It was called *xanthophana* by Müller Argau.

A. contigua is distinguished by the dark yellow color, the continuous smooth crust, the non-gomphate areolae with blackish apothecia and the distinct lumina in the cortex and the medulla.

7. **Acarospora subalbida** H. Magn. n. sp.

Lecanora xanthophana Tuck. Syn. N. Am. Lichens **1**: 202. 1882, p.p.

Thallus squamulosus, indeterminatus, squamulae dispersae vel subcontiguae, albidae, humectatae pallide citrinae, rotundae, leviter convexae, subtus pallidae. Apothecia plerumque singula, immersa, discus dilatatus planus, fusco-rufus, margine thallino prominente circumdatus. Hymenium angustum. Sporae tenuiter ellipsoideae.

Areolae dispersed or few crowded, 0.5–1 mm. broad, 0.3–0.4 mm. thick, white or with a tinge of citrine, when moistened distinctly pale citrine, smooth, slightly convex or subplane, usually round, unaltered by KOH and $CaCl_2O_2$, largely fastened to the stone with the lower pale surface.

Cortex 55–75 μ thick, upper half pale grayish yellow, not transparent, surface granular, rough, amorphous stratum indistinct but in reality consisting of the uppermost 25–35 μ, where the lumina are of a different shape. Lumina in lower part indistinct in water, in HCl somewhat distinct, 2.5–3.5 μ, irregularly angulose, leptodermatous. Gonidia 7–12 μ, almost dark yellow, stratum about 70 μ high with even upper surface, from which single very narrow strands of hyphae pass through it without sectioning the stratum. Medulla regularly developed, transparent, hyphae loosely woven, intricate, very leptodermatous, 3–4 μ, lumina rectangular. Marginal cortex pale, sometimes visible under the brim of the lower side.

Apothecia numerous, solitary or rarely two in each areola, immersed, disc 0.4–0.6(–0.7) mm. broad, plane, brownish red, round or the larger ones irregular, surrounded by the thick prominent margin of the areolae.

Exciple 15–20 μ, distinct especially at the bottom, in the margin indistinct. Hypothecium 50–70 μ, shallowly cup-like, in iodine blue. Hymenium 100–120 μ high, in iodine at first blue, soon dirty greenish or dirty vinous, uppermost 20–25 μ in water reddish brown. Paraphyses firmly coherent in rich gelatine, 1.7–2 μ thick, in water indistinctly brownish capitate, in KOH also coherent with scarcely swollen apices, 2.5 μ thick, brownish. Asci 80–95 $\times$ 20–25 μ, broadly clavate. Spores 100–200, 4–5 $\times$ 1.8–2 μ, somewhat narrowly ellipsoid.

Pycnidia not observed.

On pale calciferous sandstone, associated with *Caloplaca* conf. *ferruginea*.

U. S. A. California: Santa Monica Mts., "Topanga Canon," *H. E. Hasse*, 1909 (ex herb. Hasse in herb. B. de Lesdain) type; Texas: "in montibus Texanis coll. Wright, comm. *E. Tuck.*" (in Botanical Garden Uppsala).

Though quite chalky-white this species certainly belongs to the yellow series on account of the yellowish color in the cortex concealed by the thick amorphous stratum. The leptodermatous medullary hyphae and the firmly coherent paraphyses are also noticeable characteristics in addition to the large beautifully brown red disc when fully developed. In the specimen from

Texas the medulla is filled with masses of granules, perhaps due to a richer content of chalk in the substratum, and the apothecia are young, only 0.1–0.2 mm. in diam.

The real *A. xanthophana* from Bolivia has 2–5 mm. broad and 1–1.5 mm. thick areolae with a blackish lower side, numerous pycnidia and pachydermatous medullary hyphae.

8. **Acarospora samoënsis** H. Magn. n. sp.

Thallus indeterminatus, squamulosus, squamulae obscure citrinae vel virescente citrinae, dispersae, planae vel irregulariter convexae, gompho centrali affixae, subtus pallidae. Apothecia inconspicua, punctiformia, in squamulis singula vel pauca, immersa, disco thallo concolore. Hymenium angustum. Sporae subglobosae.

Squamulae equally dispersed above the stone with small interspaces or rarely a few contiguous, greenish yellow or dark citrine, (0.6–)1(–1.5) mm. broad, at the margin 0.2 mm. thick, at the center 0.5 mm., round or somewhat irregular in shape but not lobate, on the whole plane or slightly verrucose, with uneven surface, unaltered by KOH and $CaCl_2O_2$, fastened to the stone with a ± narrow gomphus, lower side pale.

Cortex 35–55 μ thick, upper two thirds dark dirty greenish yellow, opaque, in KOH only slightly paler, no amorphous stratum. Lumina also in HCl very indistinct, 1.5–2 μ. Gonidia 8–12 μ, in a continuous 50–90 μ thick stratum with even surface. Medulla at the margins about 100 μ thick, above the gomphus up to 500 μ, transparent. Hyphae closely intricate, 3–4.5 μ thick, somewhat conglutinate and rather pachydermatous. Lumina round or elongate or ± cylindric. Lower side towards the margins with a pale or partly yellowish brown cortex, 20–35 μ, the 0.3–0.5 mm. broad gomphus up to 0.6 mm. high.

Apothecia very inconspicuous, impressed, one or 2–3 in the areola, disc punctiform, impressed, concolorous with the thallus. No distinct exciple. Hypothecium with subhymenium 30–100 μ, in iodine dark blue. Hymenium 75–85 μ high, in iodine dark blue, uppermost 35–40 μ in water dark yellow, opaque, in KOH and HCl unchanged, surface very uneven. Paraphyses in water scarcely discernible, in KOH and HCl 1.5–1.7 μ thick, still coherent, with the apices somewhat widened, 2.5 μ, yellowish brown. Asci not well developed, about 50 × 10–17 μ, clavate. Spores about 100, broadly ellipsoid or subglobose, 3–4(–4.5) × 2–3 μ, with granular content.

Pycnidia immersed, with colorless mouth, ampullaceous, 135 μ

deep, 50–60 μ broad. Sterigmata about 12 μ, conidia 2.5–3 $\times$ 0.7 μ.

On volcanic stone without accompanying species.

HAWAIIAN ISLANDS: Oahu "auf einem ehemaligen Vulkan bei Honolulu: Punch bowl," 1905, *K. & L. Rechinger* (in Nat. Hist. Mus. Wien, determined *A. citrina* by A. Zahlbruckner). A second stone in the specimen was covered with *A. bella.*

A. samoensis is distinguished from the numerous yellow species with low hymenium by the subglobose spores. Other important characteristics are: the dispersed gomphate uneven areolae, the inconspicuous apothecia, the small cortical lumina and the firmly coherent paraphyses.

FYRADALERSGATAN 26,
GÖTEBORG, SWEDEN

MYXOMYCETES OF WESTERN WASHINGTON[1]

H. C. Greene

The Myxomycetes (slime-fungi), also often called Mycetozoa, or simply slime-moulds, are a group of fungus-like organisms, more or less minute, which successively bear the characteristics of a low type of creeping animal in their primary stages, and of an equally low type of plant in their later stages. The plant-like phase, once arrived at, ultimately gives rise again to the animal-like, which in turn produces the plant-like form again, and so on continuously through this strange, yet simple cycle. These Myxomycetes, which during their vegetative existence resemble giant amoebae, and during their reproductive period resemble the Gasteromycetes, a fungal group, but distinguished from the latter by the total lack of mycelium, have been and are claimed by both zoologists and botanists, but, as Dr. T. H. Macbride suggests, it seems very probable indeed that, strictly speaking, they are neither animals nor plants. That is to say, they form an independent, compact unit of their own.

As stated, there are two chief periods in the life-history of a Myxomycete. There is that period of the usually inconspicuous animal-like or vegetative existence, and that of the relatively conspicuous plant-like or reproductive phase. The latter is that commonly seen in the field.

The reproductive bodies, or sporangia, present great diversity as to habit, size, and appearance. On these diversities, more or less constant in the different species, the classification of the group is based. This classification, unfortunately, presents many vexing problems, and is artificial to a degree. Culture studies which will give us the complete life-histories of the various forms would seem to be necessary, if we are to comprehend with any exactness their true relationships.

The coastal belt of Washington from the summit of the

[1] This investigation was carried on in the Botany Department of the University of Washington, Seattle, under the direction of Dr. J. W. Hotson.

Cascade Range to the sea is a region especially favorable for the development of Myxomycetes. Since for their active existence they require a combination of decaying vegetable matter and considerable moisture, with accompanying moderate temperatures, in spring, in early summer, and in late fall, the lowlands of western Washington offer an abundance of these forms. At high altitudes late summer is the favorable season for collection, and, as is also the case with the higher forms of life, many unusual and interesting specimens are to be found near timberline.

It is interesting to note that, in a small woodland area on the campus of the University of Washington, the writer has been able to collect some 53 species in 21 genera. If it were practical to collect as intensively over the whole of western Washington there seems no room for doubt that the list of species following could be tremendously augmented. In the course of about one year, from November of 1927 to October of 1928, a list of 141 forms of Myxomycetes, distributed in 34 genera and including 6 varieties, which occur in western Washington has been assembled.

Some unusual forms have been collected, notably *Physarum rubiginosum* Fries, *Didymium Clavus* Rabenh., *Diderma deplanatum* Fries, *Lepidoderma Chailletii* Rost., *Liceopsis lobata* Torr., *Cribraria languescens* Rex, *Lachnobolus globosus* Rost., and *Trichia alpina* Meylan. *D. deplanatum*, *L. Chaillettii*, *L. lobata*, and *T. alpina*, apparently have not hitherto been reported from North America.

LIST OF GENERA AND SPECIES

CERATIOMYXA Schroet.

1. C. FRUTICULOSA (Muell.) Macbr.

   Common everywhere in spring and early summer in moist situations on logs.

2. C. PORIOIDES (Alb. & Schw.) Schroet.

   Collected once only at North Beach, Seattle, on rotten wood, in early spring.

   A doubtful form at best. Lister accords it varietal rank only.

FULIGO (Haller) Pers.

3. F. SEPTICA (Linn.) Gmelin.

Two of the varieties of this species which Macbride recognizes have been collected, namely *ovata*, common everywhere in spring and summer in exposed situations, and *laevis*, collected once only in late summer in Mt. Baker National Forest, at 2,000 feet, on logs.

BADHAMIA (Berk.) Rost.

4. B. PANICEA (Fries) Rost.

Vicinity of Seattle. In spring, on fir bark.

5. B. UTRICULARIS (Bull.) Berk.

Vicinity of Seattle, Renton. In spring, on fir and alder bark.

6. B. RUBIGINOSA (Chev.) Rost.

Vicinity of Seattle. Collected by Mr. John Jackal.

PHYSARUM (Pers.) Rost.

7. P. VERNUM Somm.

Quilcene. In fall, on herbaceous stalks.

8. P. SINUOSUM (Bull.) Weinm.

Seattle, Bremerton, Everett, Mt. Rainier. Spring and summer, on bark, leaves, and moss.

9. P. BITECTUM Lister.

Seattle, Kirkland. Common in fall on bark and leaves.

10. P. ALPINUM G. Lister.

Mt. Rainier. Reported by Macbride.

11. P. CONGLOMERATUM (Fries) Rost.

Mt. Rainier. Collected twice at about 5,000 feet. Late August, on needles, bark, and twigs of alpine fir.

12. P. CONTEXTUM Pers.

Seattle, Bremerton, Seabeck, Mt. Rainier. Fairly common throughout the year on bark, moss, and herbaceous matter.

13. P. CINEREUM (Batsch) Pers.

Vicinity of Seattle. Collected by Mr. John Jackal.

14. P. INSTRATUM Macbr.

Vicinity of Seattle. Collected by Mr. John Jackal.

15. P. CONFERTUM Macbr.

Vicinity of Seattle. Collected by Mr. John Jackal.

16. P. CITRINUM Schum.
Seattle, campus of the University of Washington. Early spring, on bark of living dogwood.
17. P. GLOBULIFERUM (Bull.) Pers.
Vicinity of Seattle. Collected by Mr. John Jackal.
18. P. MURINUM Lister.
Vicinity of Seattle. Collected by Mr. John Jackal.
19. P. PULCHERRIMUM Berk. & Rav.
Vicinity of Seattle. Collected by Mr. John Jackal.
20. P. PULCHRIPES Peck.
Vicinity of Seattle. Collected by Mr. John Jackal.
21. P. PENETRALE Rex.
Renton, Seabeck, Bremerton. Rare in summer, on leaves, sticks, and logs.
22. P. WINGATENSE Macbr.
Vicinity of Seattle. Collected by Mr. John Jackal.
23. P. DIDERMOIDES (Pers.) Rost.
Vicinity of Seattle. Collected by Mr. John Jackal.
24. P. COMPRESSUM Alb. & Schw.
Mt. Rainier. Reported by Macbride.
25. P. CARNEUM G. Lister & Sturgis.
Seattle, Whidby Island. Rare, in fall and early spring on bark and dead wood.
26. P. RUBIGINOSUM Fries.
Bremerton. July, on dead foliage of western red cedar. The writer is indebted to Miss G. Lister for the determination.
27. P. OBLATUM Macbr.
Seattle, Mt. Rainier. Spring and summer, on bark and dead wood.
28. P. TENEREUM Rex.
Common and widely distributed in spring and early summer on decorticate logs and sticks.
29. P. POLYCEPHALUM Schw.
Vicinity of Seattle. Collected by Mr. John Jackal.
30. P. NUTANS Pers.
The most common member of the genus in western Washington. Everywhere in spring and summer on various substrata.

31. P. NUTANS—var. LEUCOPHAEUM List.

Seattle, Seabeck, Bremerton. Spring and summer, fairly common on logs.

32. P. VIRIDE (Bull.) Pers.

Seattle, Seabeck, Bremerton, Willapa Harbor. Spring and summer, on logs.

CRATERIUM Trentepohl.

33. C. AUREUM (Schum.) Rost.

Seabeck, Silverdale, Bremerton. Summer, on leaves, grass, and sticks.

34. C. LEUCOCEPHALUM (Pers.) Ditm.

Bremerton, Everett, Seattle. Summer and fall, on leaves and sticks.

35. C. MINUTUM (Leers) Fries.

Everett. July, on leaves. Macbride states, regarding the sporangial lid, that "It is in all specimens before us much depressed below the mouth of the sporangium," and he further states that the sporangia are grayish brown. The one specimen collected by the writer shows lids which are so convex as to be almost hemispherical, and the sporangia are relatively large and bright red-brown, seeming thus to be of a type common in Europe, but not hitherto reported in the United States.

PHYSARELLA Peck.

36. P. OBLONGA (Berk. & Curt.) Morg.

Vicinity of Seattle. Collected by Mr. John Jackal.

LEOCARPUS (Link) Rost.

37. L. FRAGILIS (Dicks.) Rost.

Seattle, Bremerton, Mt. Rainier. Summer and fall, on bark and sticks.

DIDYMIUM (Schrad.) Fries.

38. D. SQUAMULOSUM (Alb. & Schw.) Fries.

Common in the Puget Sound region in fall and spring, on leaves.

39. D. MELANOSPORUM (Pers.) Macbr.

Bremerton. July, on moss, seemingly rare.

40. D. MELANOSPORUM—var. MINUS Lister.

Seattle, Kirkland, Everett, Longmire Springs. Much commoner than the typical form. Mid-summer.

41. D. CLAVUS (Alb. & Schw.) Rabenh.
Seattle. Mid-summer, on leaves. Collected once only.

42. D. NIGRIPES (Link) Fries.
Seattle, Lake Sammamish, Kirkland, Bremerton. Spring and summer, on leaves.

43. D. XANTHOPUS (Ditm.) Fries.
Seattle, Seabeck, Everett, Port Townsend. Spring and summer, on leaves and herbaceous stalks.

44. D. ANNULATUM Macbr.
Seattle. Reported by Macbride.

45. D. DIFFORME Duby.
Everett. July, on leaves and herbaceous stalks.

DIDERMA Pers.

46. D. SPUMAROIDES Fries.
Seattle, Bremerton. Not common, in summer, on leaves.

47. D. GLOBOSUM Pers.
Silverdale. Early summer, on bark and leaves.

48. D. LYALLII (Mass.) Macbr.
Mt. Rainier. Late August, rare at high altitudes, on dead wood.

49. D. TESTACEUM (Schrad.) Pers.
Kirkland. Late summer, on smooth bark of alder.

50. D. NIVEUM (Rost.) Macbr.
Widely distributed and common in summer, at varying altitudes and on varying substrata.

51. D. DEPLANATUM Fries.
Hood's Canal. Early summer, on leaves and moss.

52. D. HEMISPHERICUM (Bull.) Horne.
Reported by Macbride.

53. D. RADIATUM (Linn.) Morg.
Whidby Island. Early summer, on moss.

54. D. RADIATUM—var. UMBILICATUM Meyl.
Port Townsend, Seattle, Mt. Rainier. Summer and fall, on dead bark. More common than the typical form.

55. D. TREVELYANI (Grev.) Fries.
Vicinity of Seattle. Collected by Mr. John Jackal.

56. D. ASTEROIDES Lister.

Mt. Rainier. Late summer, at 5,000 feet, on the smooth bark of a living cedar.

57. D. FLORIFORME (Bull.) Pers.

Vicinity of Seattle. Collected by Mr. John Jackal.

LEPIDODERMA DeBary.

58. L. TIGRINUM (Schrad.) Rost.

Whidby Island, Seabeck, Bremerton, Mt. Rainier. Summer, on dead wood and moss.

59. L. CHAILLETII Rost.

Mt. Rainier, Mt. Shuksan. Late summer, on stems of living mountain ash. Determined by Miss G. Lister.

60. L. CARESTIANUM—var. GRANULIFERUM Lister.

Mt. Rainier. Late summer, on living mountain ash.

AMAUROCHAETE Rost.

61. A. TUBULINA (Alb. & Schw.) Macbr.

Seattle. Late summer, on smooth, rotten bark.

STEMONITIS (Gled.) Rost.

62. S. FUSCA (Roth.) Rost.

Common and widely distributed in summer on various substrata.

63. S. HYPEROPTA Meyl.

Common throughout the summer, on wet, rotten wood.

64. S. UVIFERA Macbr.

Reported by Macbride.

65. S. SPLENDENS Rost.

Reported by Macbride.

66. S. AXIFERA.

Common and widely distributed in summer, on the smooth bark of logs.

67. S. FLAVOGENITA Jahn.

Seattle, Renton, Mt. Rainier, Mt. Baker National Forest. In summer, on leaves and dead wood.

68. S. PALLIDA Wingate.

Longmire Springs, Mt. Baker National Forest. Late summer, on dead wood.

69. S. HERBATICA Peck.

Reported by Macbride.

COMATRICHA (Preuss) Rost.

70. C. FLACCIDA Lister.

Reported by Macbride.

71. C. IRREGULARIS Rex.

Vicinity of Seattle. Collected by Mr. John Jackal.

72. C. LAXA Rost.

Seattle. Mid-summer, on dead wood.

73. C. SUKSDORFII Ellis & Ev.

Mt. Rainier. Late summer, on dead coniferous wood at 6,000 feet.

74. C. NIGRA (Pers.) Schroet.

Seattle, Bremerton, Whidby Island. Late fall and early spring, on wet, decorticate wood.

75. C. TYPHOIDES (Bull.) Rost.

Abundant and very widely distributed throughout most of the year, on wet, rotten wood.

76. C. ELEGANS (Racib.) List.

Port Townsend. Collected once only in late fall, on fir bark.

DIACHEA Fries.

77. D. LEUCOPODA (Bull.) Rost.

Common and widely distributed in summer, on leaves, in wet, marshy situations.

ENERTHENEMA Bowman.

78. E. PAPILLATUM (Pers.) Rost.

Seattle, Seabeck, Mt. Rainier. Summer and fall, at varying altitudes, on smooth, damp wood.

LAMPRODERMA Rost.

79. L. ROBUSTUM Ellis & Ev.

Reported by Macbride.

80. L. COLUMBINUM (Pers.) Rost.

Port Townsend, Whidby Island, Seabeck, Bremerton, Mt. Rainier. Common on dead wood.

81. L. VIOLACEUM (Fries) Rost.

Mt. Rainier. Late summer, at high altitudes, on the stems of living mountain ash.

82. L. ARCYRIONEMA Rost.

Seabeck. Early summer, on rotten, decorticate log.

Licea (Schrad.) Rost.

83. L. variabilis Schrad.

Mt. Rainier. Late summer, rare at altitudes of 6,000–7,000 feet, in cracks and crevices of smooth, dry fir wood.

Lindbladia Fries.

84. L. effusa (Ehr.) Rost.

Widely distributed and common in late summer, on logs, at varying altitudes from sea level to 6,000 feet.

Tubifera Gmel.

85. T. ferruginosa (Batsch) Macbr.

Seabeck, Mt. Baker National Forest Rare in summer on mossy logs.

Reticularia (Bull.) Rost.

86. R. Lycoperdon (Bull.) Rost.

Renton. Early summer, on alder bark.

Liceopsis Torr.

87. L. lobata Torr.

Whidby Island, Longmire Springs. Specimens taken at Longmire Springs, Rainier National Park, show many free sporangia. As far as can be learned, not hitherto reported from North America. Summer, on bark and dead wood.

Enteridium Ehr.

88. E. splendens Morg.

Widely distributed and common in various situations throughout the summer.

89. E. olivaceum.

Mt. Rainier. Late summer, at 7,000 feet, on dead, dry log of alpine fir.

Dictydiaethalium Rost.

90. D. plumbeum (Schum.) Rost.

Vicinity of Seattle. Collected by Mr. John Jackal.

Cribraria (Pers.) Schrad.

91. C. argillacea Pers.

Very common and widely distributed in wet situations on coniferous wood, in spring and early summer.

92. C. macrocarpa Schrad.

Whidby Island, Mt. Baker National Forest. Summer, on rotten coniferous wood.

93. C. MINUTISSIMA Schw.

Longmire Springs. Late summer, on dead coniferous wood at 3,000 feet.

94. C. RUFA (Roth.) Rost.

Common and widely distributed in summer on dead coniferous wood.

95. C. SPLENDENS (Schrad.) Rost.

Macbride states that this species is exceedingly rare, but the writer has collected it at least 30 times, in widely separated areas, in summer, on dead coniferous wood.

96. C. AURANTIACA Schrad.

Seattle, Whidby Island, Seabeck, Bremerton. Summer, on dead coniferous wood.

97. C. DICTYDIOIDES Cooke & Balf.

Seattle, Mt. Baker National Forest. Spring and summer, on dead coniferous wood.

98. C. PIRIFORMIS Schrad.

Common and widely distributed. Late spring and early summer, on dead coniferous wood.

99. C. PIRIFORMIS—var. NOTABILIS Rex.

Seattle, Bremerton, Seabeck, Quilcene, Longmire Springs. Summer, on dead coniferous wood.

100. C. TENELLA Schrad.

Longmire Springs. Late summer, on dead coniferous wood.

101. C. PURPUREA Schrad.

Seattle, Mt. Baker National Forest. Summer, on dead coniferous wood.

102. C. ELEGANS Berk. & Curt.

Longmire Springs. Late summer, on dead coniferous wood.

103. C. LANGUESCENS Rex.

Mt. Baker National Forest. Late summer, on dead coniferous wood.

104. C. CUPREA Morg.

Vicinity of Seattle. Collected by Mr. John Jackal.

DICTYDIUM (Schrad.) Rost.

105. D. CANCELLATUM (Batsch) Macbr.

Common and widely distributed in summer on wet, rotten wood.

LYCOGALA Mich.

106. L. EPIDENDRUM (Buxb.) Fries.

Common and widely distributed in spring and summer on wet logs.

107. L. EPIDENDRUM—var. EXIGUUM Lister.

Bremerton. Late summer, on wet logs.

108. L. FLAVO-FUSCUM (Ehr.) Rost.

Bremerton. Late summer, on old stump.

MARGARITA Lister.

109. M. METALLICA (Berk. & Br.) List.

Reported by Macbride.

DIANEMA Rex.

110. D. CORTICATUM Lister.

Mt. Rainier, Mt. Shuksan. Late summer, at 5,000 feet, on the dead, dry wood of alpine fir.

111. D. ANDERSONII Morg.

Mt. Rainier, Mt. Baker National Forest. Late summer, at 2,000–5,000 feet, on dead coniferous wood and on fir bark.

LACHNOBOLUS Fries.

112. L. GLOBOSUS (Schw.) Rost.

Everett. Late summer, on a fallen alder cone. It is of interest to note the type of substratum chosen, a thing which shows that, while the range of *L. globosus* is not bound up with that of *Castanea dentata*, it nevertheless sought out a similar situation for fruiting.

ARCYRIA (Hill) Pers.

113. A. OERSTEDTII Rost.

Seattle. Rare, in spring on fir bark.

114. A. NUTANS (Bull.) Grev.

Common and widely distributed in summer, on decorticate, rather dry logs.

115. A. VERSICOLOR Phil.

Mt. Rainier. Late summer, on dead, dry wood.

116. A. INCARNATA Pers.

Exceedingly common and widely distributed, throughout the year, on dead wood.

117. A. FERRUGINEA Sauter.
Ft. Lawton, Seattle. Late fall, on dead wood.
118. A. DENUDATA (Linn.) Sheld.
Mt. Rainier. Late summer, on dead wood.
119. A. CINEREA (Bull.) Pers.
Common and widely distributed at low altitudes in summer and fall, on dead wood.
120. A. DIGITATA (Schw.) Rost.
Vicinity of Seattle. Collected by Mr. John Jackal.
121. A. INSIGNIS Kalbr. & Cooke.
Vicinity of Seattle. Collected by Dr. T. H. Macbride.

PROTOTRICHIA Rost.
122. P. METALLICA (Berk.) Mass.
Mt. Rainier, Mt. Shuksan. Late summer, on fir wood at high altitudes.

HEMITRICHIA Rost.
123. H. SERPULA (Scop.) Rost.
Mt. Rainier. Collected by Dr. T. H. Macbride.
124. H. VESPARIUM (Batsch) Macbr.
Reported by Macbride.
125. H. STIPATA (Schw.) Macbr.
Vicinity of Seattle. Collected by Mr. John Jackal.
126. H. CLAVATA (Pers.) Rost.
Seattle, Port Townsend, Bremerton, Whidby Island, Mt. Rainier. Summer, on dead wood.

TRICHIA (Hall.) Rost.
127. T. INCONSPICUA Rost.
Vicinity of Seattle. Collected by Mr. John Jackal.
128. T. ALPINA Meyl.
Mt. Baker National Forest. Late summer, at 4,000 feet, on the stems of living mountain ash.
129. T. VARIA (Pers.) Rost.
Seattle, Renton. Spring and early summer, on bark and dead wood.
130. T. SCABRA Rost.
Seattle. Fall, on bark and wood.
131. T. PERSIMILIS Karst.
Common and widely distributed in early spring and summer on various substrata.

132. T. FAVOGINEA (Batsch) Pers.

Whidby Island, Bremerton, Mt. Rainier. Summer, at varying altitudes, on wood and bark.

133. T. VERRUCOSA Berk.

Bothell, Seattle, Mt. Rainier. Summer, at varying altitudes, on dead wood.

134. T. BOTRYTIS Pers.

Seattle, Renton, Bremerton, Mt. Rainier. Summer and fall, on dead wood.

135. T. SUBFUSCA Rex.

Mercer Island, Lake Washington. Summer, on dead wood.

136. T. ERECTA Rex.

Seattle. Fall, on fir bark.

137. T. DECIPIENS (Pers.) Macbr.

Very common and widely distributed in fall, at varying altitudes, on dead wood.

138. T. LATERITIA Rex.

Seattle. Mid-summer, on wet, rotten log.

OLIGONEMA Rost.

139. O. BREVIFILUM Peck.

Reported by Macbride.

140. O. NITENS (Lib.) Rost.

Seattle. Late fall, fairly common on bark.

UNIVERSITY OF WASHINGTON,
SEATTLE, WASHINGTON

MYCOLOGICAL NOTES FOR 1926-27[1]

L. O. Overholts

(With Plates 22–25)

1. Heterosporium maculatum Klotzsch.

I collected this species abundantly in the Missouri Botanical Garden in September of 1926, on dead leaves of *Typha latifolia*. The species is probably common on that and related hosts. On comparison with specimens distributed by Klotzsch in Fung. Germ. No. *67* (Mo. Bot. Garden copy) I find agreement in all essentials. The original description gives the spores as 25–28 $\times$ 12 μ. I find them in Klotzsch's specimen and in my collection (10307) measuring 13–19 $\times$ 6–7 μ. Sporulating specimens have an olivaceous tint under a lens, becoming black as the lighter-colored spores disappear from the darker conidiophores. (Plate 24, Fig. 1.)

2. Phyllosticta Castaneae Ellis & Ev.

Collected for the first time in October, 1925, along Shaver's Creek, Huntingdon County, Pa., on *Castanea dentata*. The following notes were made from the collection:

"Spots indefinite, 3–6 mm. diameter or confluent over larger areas and then limited by the veins of the leaves, cinnamon brown in color, not margined; pycnidia immersed but most conspicuous on the lower surface, minute, black, globose, 70–90 μ diameter; spores elongate, pointed at one end, hyaline, 6–7 $\times$ 2 μ."

On living leaves of *Castanea dentata*.

The descriptions given by Seaver in North American Flora, and by Rabenhorst in the Kryptogamen-Flora, state that the pycnidia are epiphyllous. Seaver says "visible only from above." In my collection they are scarcely to be seen from the upper surface but appear distinct as seen from below.

[1] Contribution from the Department of Botany, The Pennsylvania State College, No. 65. Published by permission of the Director of the Agricultural Experiment Station, as Technical Paper No. 449.

3. SCLEROTIUM BIFRONS Ellis & Ev.

This interesting sterile fungus is fairly common in New England on *Populus tremuloides* as a small black tar-like spot on the upper surface of the leaves. In the aspen groves of Colorado I looked for it on several occasions without success in 1923, but finally found it in Boulder Park, near Tolland. It was also collected in the Jackson Hole region of Wyoming in 1926. Its distribution is not coextensive with that of its host. It seems to prefer a cool climate. In sections through the leaves, the fungous mycelium is very conspicuous, but no sign of fruiting bodies is present.

4. SPHAEROGRAPHIUM FRAXINI (Peck) Sacc.

Pycnidia spine-like, erect, flexuous when wet, brittle and prickly to the touch when dry, 1–2 mm. long, black; internally sterile and solid at the base, with an elongated sporiferous locule in the upper half; conidiophores nearly filiform, short; conidia elongated, crescent-shaped, sickle-shaped, or somewhat S-shaped, hyaline, appearing septate, with at least one septum, 42–55 × 3–4 μ.

Bursting through the outer bark on dead limbs of *Fraxinus americana*.

This species was originally described (Ann. Rep. N. Y. State Mus. **29**: 71. 1878) by Peck in the genus *Sphaeronema*. It resembles, both in appearance and structure, *S. acerinum* Peck, but the characters of the spores place it in the Scolecosporae section of the Sphaeroidaceae. The spores are described as multinucleate, and presumably one-celled, as called for in the genus *Sphaerographium*. However, I am of the opinion that they are septate, though the narrowness of the spores makes it difficult to distinguish between what might be abutting guttulae and cross septa. The accompanying illustrations (PLATE 24, FIGS. 2–4) make apparent the nature of the fungus. It is probably not uncommon in this region.

5. CORONOPHORA ANGUSTATA Fuckel.

While searching, in company with Dr. P. Spaulding, for the perithecial stage of *Melanconis Juglandis* (Ellis & Ev.) Graves

on *Juglans cinerea*, at Greenwood Furnace, Pa., an unrecognized Pyrenomycete was collected which on examination was found to have the characteristic many-spored asci shown in PLATE 24, FIG. 5. Not being familiar with an ascomycete so characterized, a portion of the collection was sent to Washington where it was identified by W. W. Diehl as the above species. Ellis and Everhart list only *C. ootheca* (Berk. & Curt.) Sacc. as known from this country and no other reference to this genus has been seen by the writer. Mr. Diehl reports that this is the first American collection known to the Washington herbarium, so that it has apparently not been widely collected, though may occur with some frequency. Unfortunately only a very limited amount of material was found, though further search in the same and in additional localities may bring more collections to light. The perithecia are quite large and occur in clusters of only two and three in this collection, bursting through the outer bark of dead branches of the host.

6. CRYPTOSPHAERIA POPULINA (Pers.) Sacc.

This was collected on dead willows, probably *Salix purpurea*, in a willow holt at Greenwood Furnace, Pa., Nov. 26, 1927, by Overholts and Spaulding. Ellis and Everhart record only *Populus* as a host. The collection is identical both externally and internally with my understanding of the fungus as it occurs on *Populus* in this region. (Overholts Herbarium 10744.) Spores very pale smoky-olivaceous, allantoid, 8.5–10 × 2–2.5 μ.

7. MYCOSPHAERELLA MACULIFORMIS (Pers.) Peck.

Every year I have collected in quantity on *Castanea* a fungus I have referred to *Phyllosticta maculiformis* Sacc. Rabenhorst and Ellis and Everhart report it as usually sterile in this stage collected in late autumn. It rarely appears much before about the time the leaves are being shed, but then very abundantly, and I have never failed to find it producing countless spermatoid spores. This year (1926) I collected on May 22, on overwintered leaves of *Quercus prinus*, a fungus that seems to be the perfect stage and is referable to *Mycosphaerella maculiformis* (Pers.) Peck. My collection is only beginning to mature

its spores and I find them 7–9 × 1.5–2 μ, which is somewhat smaller than given by others (9–14 × 3–4).

8. PROPOLIS FAGINEA (Schrad.) Karst. and Related Species.

Not much is known in this country concerning the distribution of the small wood-inhabiting apothecial fungi in the Orders Pezizales and Phacidiales. *Propolis faginea* (PLATE 22, FIG. 3; PLATE 23, FIG. 4) is represented in the herbarium of the Missouri Botanical Garden only by Wilson and Seaver's Ascomycetes and Lower Fungi, No. 44, and by the same collection from the herbarium of the North Dakota Agricultural College and Experiment Station, No. *17*.

The species was collected by the writer in November, 1926, at Arcadia, Mo., on dead wood; in Center Co., Pa., 1927, on *Hamamelis* (No. *10858*); on a dead limb on the ground in Clarion Co., Pa., 1927 (No. *10525*); on dead wood, Estes Park, Colo., Oct. 1927, by E. C. Smith (No. *10928*); and on an old *Strumella corynoidea* canker on *Quercus*, Nov. 1927, State College, Pa. (No. *10761*).

In addition to this habitat on various kinds of dead hardwoods, the old dead cones of *Pinus virginiana* and *P. pungens* and the outer dead bark of *Pinus rigida* are substrates in central Pennsylvania for a fungus that I have filed under *P. rhodoleuca* var. *strobilina* (Desm.) Phillips, based on a tentative determination by Dr. Dearness and compared with specimens so determined by Rehm. This plant was originally described as *P. strobilina* Desm., and both this and *P. rhodoleuca* (Sommerf.) Fries have been referred to *P. faginea* by some. Evidently the members of this group are very closely related to each other, and perhaps should all be referred to the same species.

On picking up this fungus, one who is familiar with *Sphaerobolus stellatus* might think he had that species in hand, since the small apothecia are sunken into the wood and never become strongly erumpent. The white hymenial surface surrounded by the ruptured wood tissue heightens this impression. The appearance of the fungus is well shown in the accompanying illustration (PLATE 23, FIG. 4).

The hymenium is fleshy when fresh and somewhat pulverulent.

When first making this identification I examined the Seaver and Wilson collection cited above. The spores there measure 15–18 × 6–7 μ and the content is broken up into two or three sections much as in the young spores of a *Pezicula*, prior to formation of septa. However, here they are said always to be unicellular and I have seen no further evidence that they do become septate. Rabenhorst gives the spore measurements as 21–27 × 6–8 μ. In my No. *10411* they measured 15–21 × 6–7 μ, in No. *10525*, 24–30 × 5–6 μ, and in No. *10792*, 15–18 × 6–9 μ. This latter number is from a collection referred to the var. *strobilina* on the loose outer bark of *Pinus rigida*. I am inclined to regard these variations in measurements as a factor of the age of the plant and to consider that probably they should all be referred to one species. The paraphyses are very narrow, 1–2 μ diameter, and branch at their apices, the branches in the Seaver and Wilson collection being considerably agglutinated to form an epithecium, and much less so in the other collections. The appearance of the fungus in section is shown in PLATE 22, FIG. 3, and the asci, spores, and paraphyses in PLATE 24, FIG. 6.

9. VALSA AND CYTOSPORA on Conifers.

The tree-inhabiting valsas and their imperfect stages in *Cytospora* present a difficult problem to both the mycologist and the pathologist. Little work has been done on the possible parasitism of these fungi. They are not uncommon on the lower dead branches of small pine trees, on sunscald areas on the bark, on the tips of white pine killed by the weevil, and in other similar situations where their parasitism is not clearly defined. The following field observations have accumulated over a period of several years.

A species I am referring to *V. Abietis* Fries has been collected as follows: on *Thuja orientalis* at State College, Penna., in 1922 (No. *8321*), on recently killed young trees with appearance as though parasitic, no other organism observed to be present; on *Larix americana* at Newcombe, N. Y., in 1924, but in the *Cytospora* stage only, on young trees with a considerable amount of winter injury, and only on the lower branches; on a recently killed sapling of *Abies balsamea*, at Willey Station, N. H., in

1924 (No. *9761*); and on recently killed trees of *Pseudotsuga mucronata* of considerable size (6–8 in. diameter) at Tolland, Colorado, in 1923 (No. *10248*). (PLATE 23, FIG. 5.) On these trees the fungus inhabited conspicuous cankered areas with the bark considerably split, and with some resin exudate. This seemed at the time as a rather clear-cut case of parasitism but inoculation experiments were not conducted.

The fungus I am referring here agrees with the above-named species as distributed in Fungi Columbiani No. *4999*. The ascospores are 6–9 $\times$ 1.5 μ and the perithecial pustules are very conspicuous, as they occur erumpent through the bark of smooth-barked trees.

Another species I had called *V. Pini* (Alb. & Schw.) Fries, until Dr. Dearness pointed out its resemblance to *V. collicula* (Wormsk.) Cooke, is common on *Pinus Strobus* in the Allegheny region. The ascospores are smaller than in either *V. Abietis* or *V. Pini* and measure 4–6 $\times$ 1 μ. I have it on a very recently killed sapling from Wayne Co., Pa. (No. *10785*); on a sunscald area on a living tree from Allegheny County, Pa. (No. *8004*); on a small dead sapling at Tupper Lake, N. Y. (No. *9621*) (PLATE 22, FIG. 2); on what appeared to be a frost canker in Huntingdon Co., Pa. (No. *8332*); one collection from a tree girdled with the "basal canker," sometimes attributed to ant injury, from the same locality (No. *8198*); and one collection from a sunscald area in the top of a 30-foot *Pinus sylvestris* in Allegheny Co., Pa. (No. *7988*). (See PLATE 24, FIG. 7.)

10. CLAUDOPUS SUBDEPLUENS Fitzpatrick.

On August 22, 1926, after copious rains, I collected on the College Campus a small *Claudopus* parasitic on the hymenium of specimens of *Cantharellus cibarius*. (PLATE 22, FIG. 1.) On comparing this with Fitzpatrick's description of the above species (Mycologia **7**: 37. 1915) it becomes apparent that the only points in which it differs from that species are in the host —the type being on *Polyporus perennis*—and in the fact that the margin of the pileus is not sulcate in my specimens. The upper surface of my specimens is distinctly silky tomentose while *C. subdepluens* is described as tomentose. The spores

agree well, my measurements being 9–11 × 6–8 μ, angular, pinkish in color. I am convinced that I have here a form of that species and undoubtedly the list of host species will eventually be considerably extended. Dr. Fitzpatrick has pointed out to me that perhaps *Leptonia parasitica* Quél. (Bull. Bot. Sci. France **25**: 287–292. 1878) is identical with his species. This species was described as on *Cantharellus cibarius*, and very likely is the same plant. It would appear to me to be better placed in *Claudopus* than in *Leptonia*.

11. NOTES ON CORTICIUM.

Corticium ermineum Burt. I studied sections of the type collection of this in 1927. (PLATE 24, FIG. 8.) Dr. Burt places this species among those thin white species not known to have chlamydospores. What these "chlamydospores" really are is not known, but in many instances they duplicate the form and size of the basidiospores and are to be regarded as basidiospores that have lodged on and become distributed through the subhymenial tissue. My sections of the type of this species show an abundance of these imbedded spores particularly in the upper half of the fructification. (PLATE 24, FIG. 9.) Curiously enough the type collection gives some evidence, though not quite conclusive, of representing a growth of two years. Such a renewal of vigorous growth immediately following a period of sporulation would in itself be enough to cause many of the basidiospores to become overgrown and enmeshed in the tissues of the new growth. Dr. Burt also reports no clamp connections on the hyphae of the subhymenial region. But clamps are present in considerable numbers in two sets of sections I made from the type collection. His records for spore size are scarcely large enough. I find spores along the surface of the hymenium up to 12 μ long (7–9 by Burt).

Corticium apiculatum Bres. This species was described by Bresadola from Weir's collection in Idaho. Bresadola does not mention gloeocystidia and Burt records the species as lacking them. I have not studied material from the type collection, but in one of my collections (*3167*), cited by Burt as belonging here, gloeocystidia are present, though relatively inconspicuous.

They are found imbedded in the subhymenial tissue, and measure about 20 × 6–8 μ. The subhymenium is fairly compact and they do not show up well until the sections have stood in KOH and eosin for about half an hour. Then they are not difficult to detect. Bresadola's spore record of 5–6 × 3 μ is in better agreement with my specimen than is Burt's (4.5–5 × 2.5–3 μ).

Corticium Overholtsii Burt. In 1918 I sent to Dr. Burt a specimen of *Corticium* on bark of *Pinus rigida* which he subsequently described (Ann. Missouri Bot. Gard. **13**: 245. 1926) under the above name. The species was described as lacking gloeocystidia. On receiving a similar collection this year from Dr. P. Spaulding, again on bark of *Pinus rigida*, from Wakeby, Mass., I was led to compare it with the above species. The Massachusetts collection had rather abundant gloeocystidia, but they did not become very apparent until the sections had stood for some time in KOH and eosin on the slide. A thorough search through the genus failed to reveal a species so characterized. Recalling the general similarity to *C. Overholtsii* I again sectioned a part of the original collection of that species and found exactly the same situation. Gloeocystidia are rather numerous but quite inconspicuous at first—in fact, barely discernible when the sections are first mounted. But after standing for an hour or more they became more conspicuous and could then be discerned in numbers. In some places they became very conspicuous, though here again it has been necessary to crush out one set of sections before I could be sure of them. They are elongated elements arising at some distance below the basidial layer and extending up between the basidia and occasionally with the tips barely projecting, and measure 7–9 μ in diameter at the thickest portion. (PLATE 25, FIG. 10.)

Otherwise the species is well described in the original except for a color variation in the Massachusetts collection. There the color is light cinnamon buff or vinaceous cinnamon (Ridgway) and hence considerably darker than in the types. In every other character the agreement is extremely close. In the subhymenium the walls of the hyphae are gelatinously modified, but again this is not very apparent, or at least becomes much more conspicuous after the sections stand in KOH for several

hours. In glycerine preparations, however, the character once established remains quite conspicuous.

The Massachusetts collection is No. *16995* of the U. S. Timber and Forest Disease Survey.

Corticium Pruni *n. sp.* Plants entirely resupinate, at first in small orbicular patches about 1 cm. diameter at the lenticels of the bark, soon effused and confluent to 5 cm. or more, adnate, cream-color, or ivory yellow to cream buff, becoming somewhat cracked on drying, thinning out on the margin, glabrous; in section 200–300 μ thick, divided into two nearly equal layers, a lower layer of longitudinally and compactly arranged hyphae, and a subhymenial layer that bears numerous gloeocystidia and in which the hyphae are sub-erect; spores oblong-ellipsoid or short-cylindric, hyaline, smooth, 5–6 $\times$ 3 μ; hymenial cystidia lacking; gloeocystidia abundant, elongate, 6–7 μ diameter, entirely imbedded and tapering into a narrow flexuous hyphal portion that penetrates through the basidial layer but does not project; hyphae branched, hyaline, with very inconspicuous cross walls and clamps, diameter 2–3 μ.

On bark of dead *Prunus*. North Conway, N. H., Aug. 18, 1918. L. O. Overholts, No. *5111*. (PLATE 23, FIG. 6; PLATE 25, FIGS. 11, 12.)

The species is similar in aspect to *Peniophora albula* Atk. & Burt. but has prominent gloeocystidia with granular content. Externally it is similar to some collections of *Peniophora mutata* and *P. Allescheri* but the spores are very much shorter and the hyphae much smaller, while in sections made at a half dozen different places I have failed to find cystidia, although in some sections a few of the gloeocystidia do not taper to the narrow elongated tip. Another near relative is *Corticium stramineum* Bres. from which it differs in the thicker fruiting body and in the abruptly narrow tips of the gloeocystidia. As in that species there is a definite substratal layer of horizontal hyphae. Neither is there any indication that the fungus would ever grow pileate, and it is, therefore, probably not a *Stereum*. The cream color, the two layers of the subhymenium, and the presence of gloeocystidia but no cystidia, with short spores 4–6 $\times$ 3 μ, would appear to be the distinguishing features of the species.

12. **Hypochnus pennsylvanicus** sp. nov.

Effused for only a few centimeters, rather thick and compact for the genus, "olive buff" or "pale olive buff," separating easily as a thin membrane, the margin somewhat fimbriate and with a few mycelial cords of the same color; in section 150–180 μ thick, the subhymenium loosely constructed of pale ascending hyphae 4–6 μ diameter, with cross walls but no clamp connections; spores globose, echinulate, hyaline under the microscope, 5–6 μ diameter; cystidia none; basidia 6–7 μ diameter.

On rotten bark of *Carya*.

Type collected at Musser Gap, Center Co., Pa., Nov. 25, 1927, by L. O. Overholts and P. Spaulding (Overholts Herb. *10773*).

The species is apparently closely related to *H. cinerascens* Karst., but is of rather different color, thinner, and the hyphae lack clamp connections. In Burt's treatment of the genus it falls near *H. zygodesmoides* (Ellis) Burt, from which the very different color and the habitat would seem to distinguish it. The structure in section is shown in PLATE 25, FIG. 13.

13. STEREUM RUGISPORUM (Ellis & Ev.) Burt.

This species is not uncommon in the Rocky Mountain States. I have collected it several times in Colorado—always on coniferous wood. On first meeting it, one who is familiar with *Stereum fuscum* (Schrad.) Quel. (= *S. bicolor* Pers.) will be tempted to refer it to that species, with which its superficial aspect is in rather close agreement, but from which it differs in internal structure and in being confined to coniferous wood. Since no good illustrations of its internal structure have appeared, I take the opportunity offered on the receipt of a specimen recently from E. C. Smith, Fort Collins, Colo., to elucidate that point.

The specimens are thick and spongy for a *Stereum* and when the hymenium is examined under a hand lens it may show one of three conditions: (*a*) There may appear prominent, very slender bristles or hairs protruding from the hymenium. These are of the nature of brown cystidial hyphae, 7 to 9 μ diameter, thick walled, and projecting up to 135 μ. They are not setae, in spite of their brown coloration, for they do not become darker in KOH solution as do setae in other genera of Hymenomycetes.

(*b*) The hymenium may be smooth, *i.e.* without these hairs, which in such cases have probably been broken off in handling the specimen, since in all cases sectional preparations show them to be present in the hymenium and the subhymenium. Moreover, they are extremely fragile—so much so that in cutting sections it is necessary to so orient the hymenial surface in the pith that the latter does not press upon these hairs. Otherwise, at least the longer of them will be broken off. (*c*) The hymenium may have the appearance of being covered and somewhat pruinose from the presence of small curved glistening-white mycelial or cobwebby filaments. I have seen a few cases where these appear to originate, perhaps only in young specimens, as hyaline hyphae growing out from the lumen of broken ends of these cystidia, and curving back over the hymenial layer in the form of shepherd's crooks.

Internally, sections of one-year-old specimens show a layer of elongate basidia between which these cystidia protrude conspicuously. (PLATE 25, FIG. 14.) Also many of the latter appear, in older specimens at least, never to reach the surface of the hymenium, but are completely imbedded. Basidiospores are usually abundant in the specimens I have examined and are as described by Burt, except that they frequently reach sizes of as much as $15 \times 6\ \mu$. In my collections both basidia and spores are so large and the latter so constantly present that the species is an excellent one for class use in demonstrating a functional basidial hymenium. The sterigmata are unusually large, measuring 6–8 μ long.

In the subhymenium and often in the basidial layer Burt describes the presence of brown spore-like bodies as occurring in many specimens though not in all. I find the same in my specimens. Unfortunately Burt's illustration of those bodies is not at all typical. I have seen bodies such as he represents deep in the subhymenium, or really in the context tissue of the pileus, and they are different in appearance from the spore-like bodies, having more the appearance of small bundles of organic material as though of a small knot of extremely minute hyphae, but they are so dense that their structure cannot well be made out. (PLATE 25, FIG. 15.) The spore-like bodies, when present,

are nearer the basidial layer and show definitely the form of spores, though often they are grouped in twos, threes, or fours. (PLATE 25, FIG. 16.) It is, of course, possible that the knotted bodies are clumps of these spore-like bodies that have undergone disintegration, but even in the most favorable sections they show nothing of such an origin.

My illustration of the hymenial region (PLATE 25, FIG. 14) shows but a single layer of basidia, but the fungus is evidently perennial as the hymenium becomes several layered in age.

14. PORIA CORTICOLA (Fries) Cooke.

Since my previous description (Bull. Torr. Bot. Club **50**: 245–247. 1923) of this species, I have received many additional specimens and have studied each one with care. I am compelled, as a result, to allow still more latitude in the matter of cystidia. Certain collections, typical in all other respects, show American plants to possess at times cystidia that are even more conspicuous than those of European plants communicated by Romell. They are very heavily incrusted with large, coarse, often sharp-pointed crystals as seen in the accompanying illustration (PLATE 25, FIGS. 17, 18). These together with the highly characteristic hyphae already illustrated make this form of the species very easy to recognize. In addition to the collections previously reported, I have additional ones from Winnipeg, Canada, G. R. Bisby, *1180*, *1335;* Bethel, Vt., P. Spaulding, no. *16926*, on *Populus tremuloides;* Cheekye, Brit. Col., on *Thuja plicata*, J. S. Boyce (*1069*); Denver, Colo., on *Populus Sargentii*, E. Bethel.

15. PORIA DECOLORANS (Schw.) Cooke.

Several of the species described by Peck and by Schweinitz are known only from the original collections. This may not be due so much to the rarity of the species as to the fact that this group presents difficulties of identification that have discouraged collecting. It is a real pleasure to re-discover these old species. The latest one to come to my attention is a collection of *P. decolorans*, taken near State College, Nov. 25, 1927, on an old hickory log, by the writer in company with Dr. P. Spaulding. The type collection is not abundant and yielded rather unsatisfactory

results when studied by me several years ago. However, the large amount of crystalline material in the tramal tissue near the bottom of the tubes, often indefinite in arrangement but at times as rather definite incrusted cystidia, the globose spores, and the strong discoloration on drying were pointed out then as characteristic features of the species.

I can add little, however, to the diagnosis already given (Mycologia **15**: 213. 1923). The spores seem to be 5–6 μ diameter rather than 4–5 μ. The same accumulation of crystalline material is found near the bottom of the tubes and in all other respects the collection duplicates the type, except that I would describe this collection as separable from the substratum rather than as inseparable. The color of the fresh material is white, but, on drying, part has become smoky-black and part yet darker.

THE PENNSYLVANIA STATE COLLEGE,
STATE COLLEGE, PA.

EXPLANATION OF PLATES

PLATE 22

Fig. 1. *Claudopus subdepluens* on the hymenium of *Cantharellus cibarius*. Collected at State College, Pa., Aug. 22, 1926. × 2.

Fig. 2. *Valsa collicula*. Vertical section through perithecial stroma. Overholts Herb. 9621. × 79.

Fig. 3. *Propolis faginea*. Vertical section through an erumpent apothecium. Overholts Herb. 10792. × 110.

PLATE 23

Fig. 4. *Propolis faginea*. Decorticated limb showing the white erumpent apothecia. Overholts Herb. 10525. × 3.

Fig. 5. *Valsa Abietis*. Pycnidial pustules with spore horns, in a dead area in the bark of living *Pseudotsuga mucronata*. Overholts Herb. 10248. × 2.

Fig. 6. *Corticium Pruni*. Photo of a portion of the type collection. Overholts Herb. 5111. × 1.

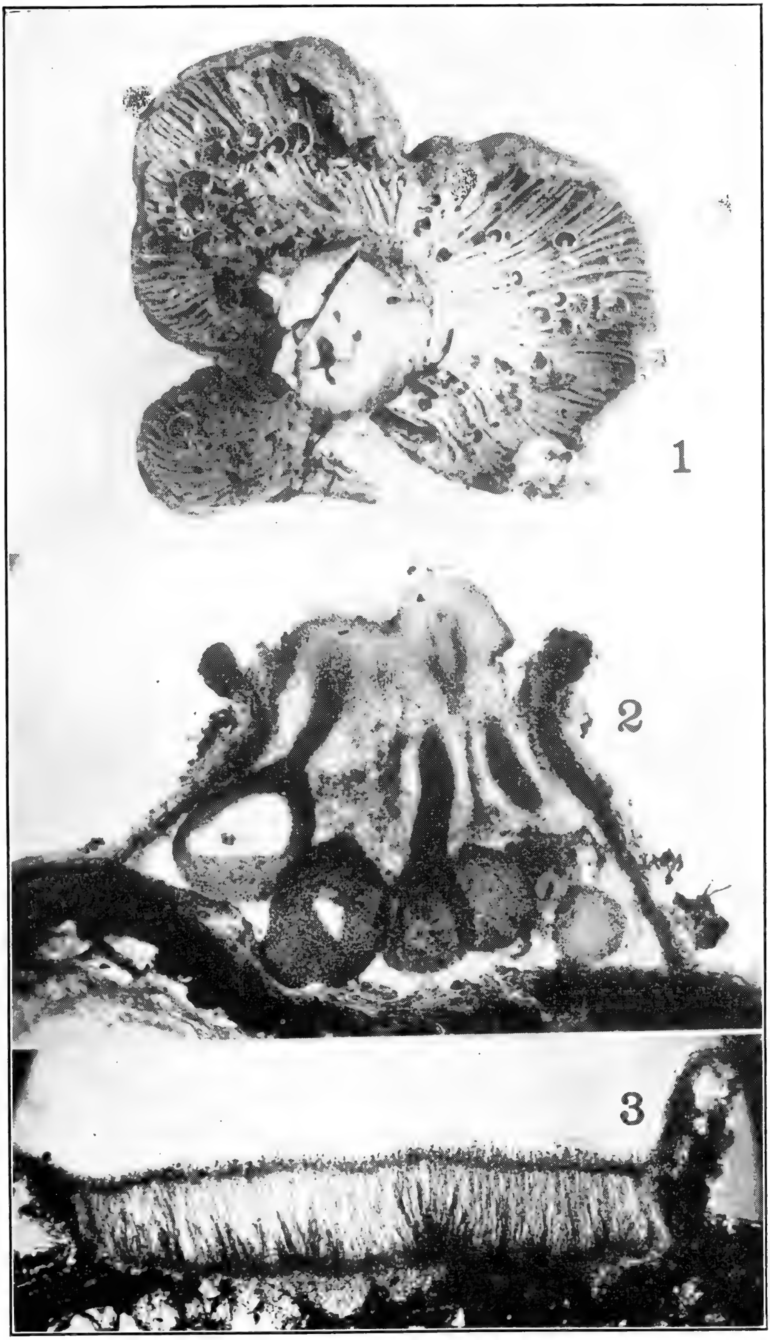
PLATE 24

Fig. 1. *Heterosporium maculatum*. A. Conidiophores and conidia. No. 10307. B. Spores from Klotzsch, Fungi Ger. 67. × 425.

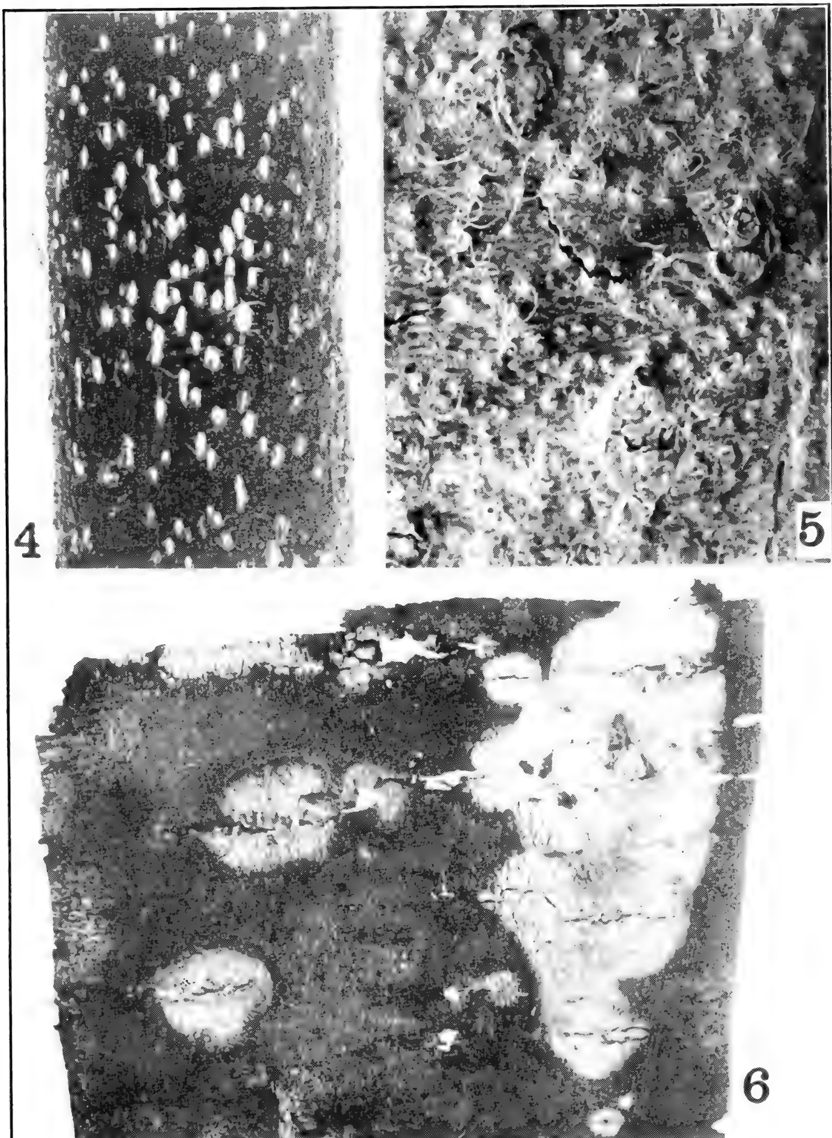
Fig. 2–4. *Sphaerographium Fraxini*. 2. Longitudinal section through the stalked spine-like pycnidium, showing the locule in the upper portion. × 75. 3. The elongated spine-like fruiting bodies on branch of *Fraxinus*. × 1½. 4. Spores from the pycnidium. × 425. No. 10784.

Fig. 5. *Corcnophora angustata*. Asci and spores. × 425. No. 10752.

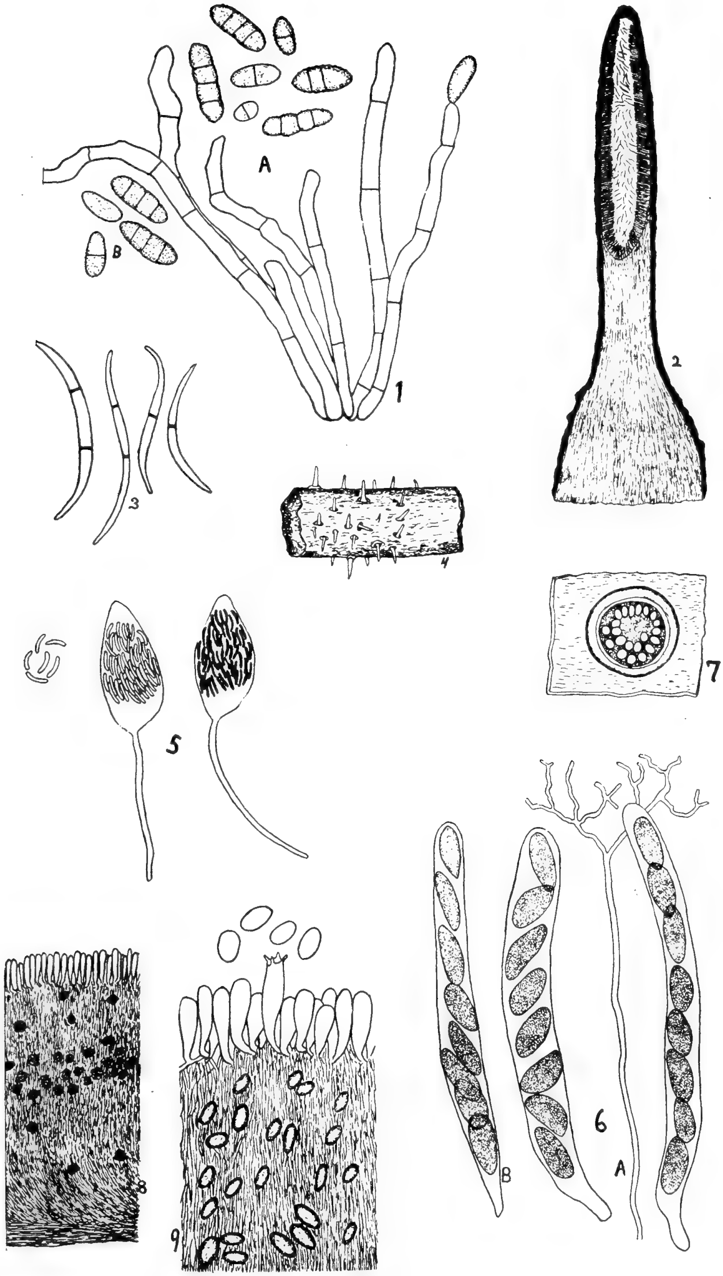
Fig. 6. *Propolis faginea*. A. Asci, spores, and a single branched paraphysis. No. 10792. B. Single ascus with spores. No. 10794. × 425.



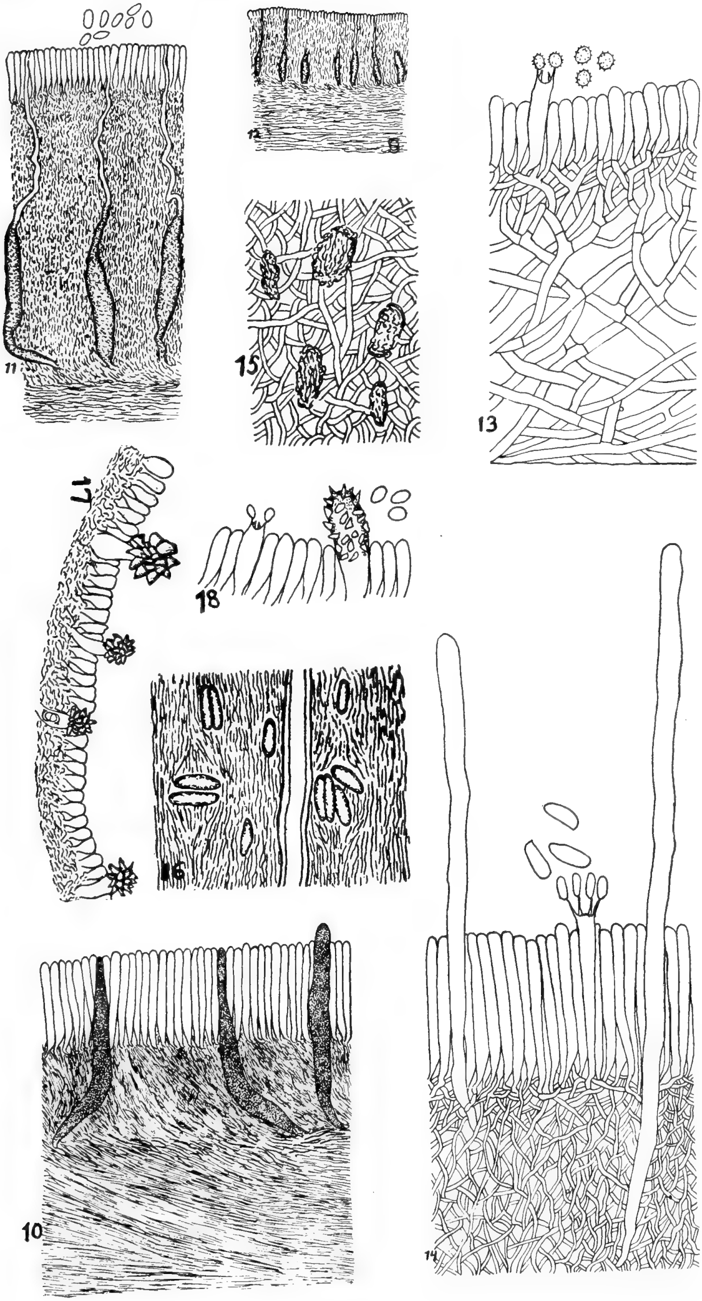
1. Claudopus subdepluens; 2. Valsa Collicula; 3. Propolis faginea



4. Propolis faginea; 5. Valsa Abietis; 6. Corticium Pruni



1. Heterosporium maculatum; 2–4. Sphaerographium Fraxini; 5. Coronophora angustata; 6. Propolis faginea; 7. Valsa collicula; 8–9. Corticium ermineum



10. CORTICIUM OVERHOLTSII; 11–12. CORTICIUM PRUNI; 13. HYPOCHNUS PENNSYLVANICUS; 14–16. STEREUM RUGISPORUM; 17–18. PORIA CORTICOLA

Fig. 7. *Valsa collicula.* Perithecial stroma with the upper portion cut off, to show the number and arrangement of the internal locules. No. 10785. × 6.

Fig. 8, 9. *Corticium ermineum.* 8. Vertical section through fruiting body, showing the narrow substratal layer of horizontal hyphae and the layer of crystalline material below the hymenium. × 50. 9. Vertical section through the hymenial layer and the adjacent subhymenium, showing spores, basidia, and the imbedded spores. × 425. Both from the type collection.

PLATE 25

Fig. 10. *Corticium Overholtsii.* Vertical section through fruiting body, showing the imbedded gloeocystidia. From type. × 425.

Fig. 11, 12. *Corticium Pruni.* 11. Vertical section through the upper half of the fruiting body, showing spores, basidia, and the flexuous gloeocystidia with attenuate tips reaching the level of the hymenium. × 310. 12. Vertical section through the entire fruiting body, showing the location of the gloeocystidia. × 85. Both from type collection.

Fig. 13. *Hypochnus pennsylvanicus.* Vertical section through fruiting body. × 320. From type collection.

Fig. 14–16. *Stereum rugisporum.* 14. Vertical section through the hymenial and subhymenial region of the fruiting body, showing cystidia and spores. No. 10414. × 400. 15. Irregular knotted bodies found in the deeper portion of the subhymenium. × 800. 16. A small portion from the subhymenium, showing the imbedded spore-like bodies. A portion of a cystidium crosses the section. Herb. Mo. Bot. Garden 62967. × 800.

Fig. 17, 18. *Poria corticola.* 17. Section of hymenial layer showing cystidia with large irregular crystals. × 600. 18. A single cystidium in the hymenium, of somewhat different form; also spores. × 800. Both from No. 7941.

COLLECTIONS OF RUSTS MADE IN NEW YORK STATE

W. R. Hunt

Three months of the field season of 1927 were spent by the writer in the southwestern part of the Central Adirondacks, five days on Long Island and part of a day on Fishers' Island.

Rust collections were made whenever the opportunity presented itself. They are deposited in the Pathological Collections of the Bureau of Plant Industry, Washington, D. C., and in the writer's herbarium, which is at Osborn Botanical Laboratory, Yale University.

The Mohawk, Black and Moose river valleys are great repositories for host plants, but there is a scarcity of parasitic fungi, especially of the order Uredinales. Comparatively few host plants were seen on Long Island or Fishers' Island, as it was late in the season.

A total of ninety-seven collections and observations was made, representing nine genera and forty-two species. They are listed alphabetically. The observations are marked by an asterisk. The following are not listed in Arthur's North American Flora from New York state: *Coleosporium Solidaginis* on *Pinus resinosa* and *Aster prenanthoides; Cronartium ribicola* on *Ribes prostratum; Gymnoconia interstitialis* on *Rubus villosus; Melampsora americana* on *Salix fragilis; M. Euphorbiae* on *Euphorbia Cyparissias; Peridermium Cerebrum* on *Pinus sylvestris; Puccinia Urticae* on *Carex vesicaria* var. *monile* and *Uromyces caryophyllinus* on *Dianthus Caryophyllus* (listed in early state agriculture experiment stations reports).

Coleosporium delicatulum (Arth. & Kern) Hedge. & Long. On *Solidago graminifolia* (L.) Salisb.: III, Boonville, Sept. 23, '27.

Coleosporium Solidaginis (Schw.) Thüm. On *Pinus resinosa* Ait.: I, Forestport, July 10, '27; I, Woodgate, July 12, '27. On *Aster prenanthoides* Muhl.: II, Boonville, Sept. 7, '27. On *Aster sp.:* II–III, Cold Spring Harbor, L. I., Nov. 19, '27;

II, Westbury, L. I., Nov. 18, '27. On *Solidago bicolor* L.: II–III, Boonville, Sept. 23, '27. On *Solidago juncea* Ait.: II, Boonville, Oct. 1, '27. On *Solidago rugosa* Mill.: II, Bald Mt., Sept. 5, '27; II, Boonville, Sept. 7, '27; II, Woodgate, Sept. 6, '27.

CRONARTIUM COMPTONIAE Arth. On *Pinus sylvestris* L.: I, Woodgate, July, '27. On *Myrica asplenifolia* L.: II–III, Central Islup, L. I., Nov. 20, '27.

CRONARTIUM RIBICOLA Fisch. On *Ribes prostratum* L'Her.: III, Bald Mt., Sept. 5, '27.

GYMNOCONIA INTERSTITIALIS (Schl.) Lagerh. On *Rubus sp.* (wild raspberry): I, Old Forge, July 4, '27. On *Rubus sp.* (wild blackberry): I, Woodgate, July 9, '27. On *Rubus sp.* (wild red raspberry): III, Woodgate, Aug. 21, '27. On *Rubus villosus* Ait.: III, Woodgate, Aug. 22, '27.

* GYMNOSPORANGIUM GERMINALE (Schw.) Kern. On *Juniperus virginiana* L. was observed to be rather common in the region of Cold Spring, L. I.

GYMNOSPORANGIUM JUNIPERI-VIRGINIANAE Schw. On *Juniperus virginiana* L.: III, Cold Spring, L. I., Nov. 21, '27; Cold Spring Harbor, L. I., Nov. 19, '27.

GYMNOSPORANGIUM SP. On *Crataegus sp.:* Forestport, July 10, '27.

KUEHNEOLA ALBIDA Magn. On *Rubus allegheniensis* Porter: II, Boonville, Sept. 23, '27; II, Woodgate, Aug. 21, '27. On *Rubus hispidus* L.: II, Woodgate, Aug. 21, '27.

MELAMPSORA AMERICANA Arth. On *Salix cordata* Muhl: II–III, New Hartford, Sept. 28, '27. On *S. fragilis* L.: II–III, Boonville, Sept. 26, '27. On *S. petiolaris* Sm.: II, Woodgate, Sept. 1, '27. On *Salix sp.:* II, Boonville, Sept. 7, '27.

MELAMPSORA EUPHORBIAE (Schüb.) Cast. On *Euphorbia Cyparissias* L.: II, Boonville, Sept. 7, '27.

MELAMPSORA MEDUSAE Thüm. On *Populus tremuloides* Michx.: II, Boonville, Sept. 7, '27; II, Woodgate, Aug. 21, '27.

* PERIDERMIUM CEREBRUM Peck. The aecial stage of *Cronartium Quercus* (Brond.) Schröt. on *Pinus sylvestris* L. was observed on Fishers' and Long Island but no collections were made.

PHRAGMIDIUM POTENTILLAE-CANADENSIS Diet. On *Potentilla canadensis* L.: II–III, New Hartford, Sept. 28, '27.

PHRAGMIDIUM ROSAE-SETIGERAE Diet. On *Rosa carolina* L.: III, Fishers' Island, Nov. 17, '27.

PUCCINIA ANDROPOGI Schw. On *Andropogon scoparius* Michx.: III, Fishers' Island, Nov. 17, '27; Central Islup, L. I., Nov. 20, '27.

PUCCINIA ANEMONES-VIRGINIANAE Schw. On *Anemonae virginiana* L.: III, Boonville, Sept. 26, '27.

PUCCINIA ANGUSTATA Peck. On *Scirpus cyperinus* (L.) Kunth.: II–III, Woodgate, Sept. 1, '27.

PUCCINIA ASPARAGI DC. On *Asparagus officinalis* L.: II–III, Boonville, Oct. 1, '27.

PUCCINIA ASTERIS Duby. On *Aster cordifolius* L.: III, Cold Spring Harber, L. I., Nov. 19, '27.

PUCCINIA ASTERUM (Schw.) Kern. On *Solidago sp.:* 0–I, Forestport, July 10, '27.

PUCCINIA BARDANAE Corda. On *Arctium minus* Bernh.: III, Boonville, Oct. 1, '27.

PUCCINIA CLEMATIDIS (DC.) Lagerh. On *Clematis virginiana* L.: 0–I, Forestport, July 10, '27. On *Agropyron repens* (L.) Beauv.: II, Boldt Island, St. Lawrence River, Aug. 14, '27; II, Clinton, Sept. 15, '27; II, Woodgate, Sept. 1, '27.

PUCCINIA CNICI Mart. On *Cirsium lanceolatum* (L.) Hill: II–III, New Hartford, Sept. 28, '27.

PUCCINIA CORONATA Corda. On *Avena sativa* L.: II–III, Westbury, Nov. 18, '27. On *Holcus lanatus* L.: II, Central Islup, L. I., Nov. 20, '27; II–III, Woodgate, Sept. 6, '27.

PUCCINIA GRAMINIS Pers. On *Berberis vulgaris* L.: 0–I, Forestport, July 10, '27. On *Agrostis alba* L.: II–III, Boonville, Sept. 7, '27; II, Central Islup, L. I., Nov. 20, '27; III, New Hartford, Sept. 28, '27; III, Woodgate, Sept. 1, '27. On *Phleum pratense* L.: II, Big Moose Lake, Sept. 5, '27; II, Boonville, Sept. 7, '27; II, New Hartford, Sept. 28, '27; II, Westbury, L. I., Nov. 18, '27; II, Woodgate, Sept. 1, '27.

PUCCINIA GROSSULARIAE (Schum.) Lagerh. On *Carex scabrata* Schw.: II–III, Bald Mt., Sept. 7, '27. On *Carex debilis* var. *Rudgei* Bailey: II–III, Boonville, Sept. 7, '27.

PUCCINIA HIERACII (Schum.) Mart. On *Taraxacum officinale* Weber: II, Boonville, Sept. 15, '27; II, Forestport, July 10, '27; I, New Hartford, Sept. 28, '27; II–III, Roslyn, L. I., Nov. 22, 27; II, Woodgate, July 9, '27.

PUCCINIA MALVACEARUM Bert. On *Althaea rosea* Cav.: III, Clinton, Sept. 16, '27; III, Cold Spring Harbor, L. I., Nov. 19, '27; III, Woodgate, July 9, '27. On *Malva rotundifolia* L.: III, Clinton, Sept. 28, '27; III, Cold Spring Harbor, L. I., Nov. 19, '27.

PUCCINIA MENTHAE Pers. On *Mentha spicata* L.: II–III, New Hartford, Sept. 28, '27. On *Satureja vulgaris* (L.) Fritsch: II–III, Boonville, Sept. 7, '27.

PUCCINIA PIMPINELLAE (Str.) Mart. On *Osmorhiza sp.:* II–III, Cold Spring Harbor, L. I., Nov. 21, '27.

PUCCINIA POARUM Niel. On *Poa annua* L.: II, Westbury, L. I., Nov. 18, '27.

PUCCINIA SUAVEOLENS (Pers.) Rostr. On *Cirsium arvense* (L.) Scop.: III, Boonville, Sept. 23, '27; III, New Hartford, Sept. 28, '27.

PUCCINIA URTICAE (Schum.) Lagerh. On *Carex versicaria* var. *monile* (Tuckerm.) Fern.: II–III, Boonville, Sept. 23, '27.

PUCCINIA VIOLAE (Schum.) DC. On *Viola eriocarpa* Schwein.: III, Boonville, Sept. 7, '27. On *Viola sp.:* III, Bald Mt., Sept. 5, '27; III, Big Moose Lake, Sept. 5, '27.

UROMYCES CARYOPHYLLINUS (Schrank) Wint. On *Dianthus Caryophyllus* L.: II, Clinton, Sept. 15, '27.

UROMYCES HYBRIDI Davis. On *Trifolium hybridum* L.: II–III, Forestport, July 10, '27; II–III, New Hartford, Sept. 28, '27; III, Westbury, L. I., Nov. 18, '27; II, Woodgate, July 12, '27.

UROMYCES HYPERICI-FRONDOSI (Schw.) Arth. On *Hypericum virginicum* L.: II–III, Forestport, Aug. 22, '27.

UROMYCES PEDATATUS (Schw.) Sheldon. On *Andropogon virginicus* L.: III, Westbury, L. I., Nov. 18, '27.

UROMYCES SILPHII (Burr.) Arth. On *Juncus tenuis* Willd.: II–III, Deer Range Park, L. I., Nov. 20, '27.

UROMYCES TRIFOLII (Hedw. f.) Lév. On *Trifolium pratense* L.: II–III, Boonville, Sept. 7, '27; II–III, New Hartford, Sept. 28, '27; II–III, Westbury, L. I., Nov. 18, '27.

UROMYCES TRIFOLII-REPENTIS (Cast.) Liro. On *Trifolium repens* L.: II–III, Boonville, Sept. 15, '27; II–III, Johnstown, July 9, '27.

OFFICE OF FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

HISTORY OF MYCOLOGICAL COLLECTORS IN COLORADO[1]

Paul F. Shope

Mycological work in the state of Colorado, as well as in all the Rocky Mountain states, is a branch of botanical science which has never been duly accredited. Thirty-three recognized collectors have visited or lived in Colorado and fifteen amateurs have collected in this region. I am excluding all workers in the Myxomycetes on account of the rather debatable taxonomic position occupied by this group of organisms.

There have appeared in recognized scientific journals several articles on Colorado fungi based on the collections made by one or more men over a period of one or two summers. Three of these articles are of importance, representing at least the beginning in the compilation of a check-list of Colorado fungi. Other papers are of minor importance, containing but scattered reports on a dozen or more fungi.

The first paper to appear dealing with fungi from this region was prepared by T. C. Porter and J. M. Coulter, 1874 (**1**). In their "Synopsis of the Flora of Colorado," they list, in addition to many hundred flowering plants, eleven fungi all of which were described by Peck. Another early paper was by Charles H. Peck, 1878 (**2**), in which he describes eleven new species of fungi from Colorado. Evidently, Peck never was in Colorado. Fungi collected in this state by T. S. Brandegee in 1877 were sent to E. S. Rau, Bethlehem, Pennsylvania, for identification. These fungi were, in turn, sent by Rau to Peck in New York. The third paper to appear in the literature was written by Ellis and Everhart in 1893. In their article entitled, "New west American fungi" (**3**), they describe ten new fungi collected in the vicinity of Fort Collins by C. F. Baker during the years 1892–1893. Baker was then with the Colorado Agricultural

[1] Read before the Botanical Section of the Colorado-Wyoming Academy of Science at the Laramie, Wyoming, meeting, November 26, 1927.

College, Fort Collins, Colorado. In 1899, T. D. A. Cockerell wrote a short article on the fungi of Custer County, Colorado (**4**). This article contains notes on the distribution and life-cycle of one smut, two rusts and one *Claviceps*.

All of the above mentioned collectors were mainly interested in the flowering plants of the region in which they were working. Collecting of fungi was purely incidental with them. The first article written by a mycologist who actually visited this state was by J. C. Arthur (**5**). Arthur and F. D. Kern came to Denver in the spring of 1907. Accompanied by E. Bethel, who was then located in Denver, these men collected rusts in the foot-hill region from Eldorado Springs to Boulder, Colorado; and also in the vicinity of Glenwood Springs, Colorado. Snow interfered with extensive trips throughout the state, but in their two-day trip they found several new rusts which were later described by F. D. Kern (**6**). Kern made a second collecting trip to Colorado in the summer of 1908 (**7**, **8**).

Fred J. Seaver made a trip to Colorado during the summer of 1910. Bethel of Denver accompanied Seaver on most of his collecting trips in this region. Collections were made at Tolland, Golden and Geneva Creek Canyon. Approximately 900 specimens of fungi were collected. Seaver published but one article on his collections which dealt entirely with the Discomycetes (**9**). He described four new species from Colorado.

A paper of more general nature appeared in 1919, in which all groups of fungi, except the rusts and smuts, were reported on. This paper was prepared by L. O. Overholts and represents the results of two summers' collecting (1913–'14) in the vicinity of Tolland and Denver, Colorado (**10**). His report was primarily a check list, but the author states: "A considerable amount of information was collected as to the altitudinal distribution, seasonal appearance, and other ecological data pertaining to the fleshy fungi, but its publication is withheld for the present with the hope of adding to it in the near future" (**11**). Overholts collected approximately 300 specimens of fungi and reports on 152 of these. This writer has made two additional trips to Colorado since his report was published; one in the summer of 1923, and a very short trip in 1926.

The last paper to appear, in which all groups of fungi are reported on, was by C. H. Kauffman (**12**). Kauffman spent the month of August, 1917, at Leal, Grand County, Colorado. In 1920, he made another trip to Colorado accompanied this time by two students. The latter summer was spent on the eastern slope and in the vicinity of Tolland, Colorado. He reports on 366 species of fungi, naming 12 new species, 2 new varieties and 2 new combinations.

Colorado fungi may be found in several standard herbarium collections which have been distributed, to some extent, throughout the United States. "*Cryptogamae Formationum Coloradensium*" is based on the collections of F. E. and E. S. Clements. These collections were made from various stations throughout the state from 1899 to 1907. "Plants of Colorado," distributed from the University of Wyoming, Laramie, Wyoming, contains many rusts collected by Leslie N. Goodding in 1903 and determined by J. C. Arthur. "Plants of Southern Colorado" contains some fungi collected by C. F. Baker from 1892 to 1899; and also some collections of fungi by D. M. Andrews, collected from 1895 to 1897. Ellis and Everhart identified all of Baker's fungi that appear in this collection. "Colorado Fungi," collected by C. S. Crandall from 1893 to 1899, contains approximately 200 different species. Crandall was then connected with the Colorado Agricultural College, Fort Collins, Colorado.

A history of mycological collectors in Colorado would not be complete unless we should include the work of the late Ellsworth Bethel. Bethel collected fungi in Colorado from 1894 to 1925, which date marked his untimely death. The last few months of Bethel's life were spent in the preparation of several papers, which, no doubt, would have contained much valuable information. After his death, Mrs. Bethel sent all of these unfinished papers, with a larger part of his cryptogamic herbarium, to the United States Department of Agriculture, Washington, D. C. The remaining part of his herbarium was divided between the University of Colorado and the Colorado Agricultural College.

Fred J. Seaver, in an article entitled "Ellsworth Bethel," states: "While the number of mycological articles accredited to him is surprisingly small, his collections have furnished the

groundwork for a number of articles contributed by other mycologists," and ". . . it is difficult to go far in the herbarium (New York Botanical Garden) without encountering fungi collected in Colorado by Bethel" (**13**).

The influence and personality of Ellsworth Bethel was more far-reaching than his publications. He was always ready to accompany and guide visiting mycological collectors to those grounds which his years of experience taught him to be the best in the state. Bethel accompanied on collecting trips all of the more outstanding mycological collectors who visited this state from 1893 to 1925. His name is found on collections from Colorado with those of Fred J. Seaver, E. Bartholomew, Arthur and Kern, L. O. Overholts, G. G. Hedgecock and C. L. Shear. Although his sudden death arrested the work of compiling and writing up the vast amount of information he had gathered throughout his years of collecting, his influence is indelibly written in the biological history of the state of Colorado.

Following is as complete a list of men who have collected fungi in the state of Colorado as I have been able to gather. In most cases, the date during which they collected in the state is included. In some instances, the dates are not definitely known by me:

Andrews, D. M.	1895–1897
Arthur, J. C.	1907
Baker, C. F.	1892–1899
Bartholomew, E.	1914
Bethel, E.	1894–1925
Bessey, C. E.	1894–1899
Brandegee, T. S.	1874–1878
Clements, F. E. and E. S.	1899–1916
Cockerell, T. D. A.	1895–1900
Coulter, J. M.	1872
Crandall, C. S.	1893–1899
Demetrio, C. E.	
Duggar, B. M.	1916
Earle, F. S.	1898
Evans, A. W.	1886–1887
Galloway, B. T.	1886–1887
Goodding, L. N.	1903
Harper, E. T.	?
Hartley, C.	1909–1912
Hedgecock, G. G.	1909–1921
Hodson, E. R.	?
Humphreys, C. J.	1905 (?)
Kauffman, C. H.	1907 and 1920
Kern, F. D.	1907–1908
Learn, C. D.	1920–1926
Longyear, B. O.	1913–1925
Overholts, L. O.	1913–1914, '23 and '26
Pammel, L. H.	1895–1897
Parry, C. C.	1861
Porter, T. C.	1872
Seaver, F. J.	1910
Shear, C. L.	1900
Shelby, (?)	1900 (?)
Tracy, S. M.	1886–1887
Trelease, W.	1886
Underwood, L. M.	1901

From the "Mycological Notes" of C. G. Lloyd, I find that the following named persons have collected fungi in Colorado and sent the material to Lloyd for identification:

Bethel, E.	1916–1919
Hassler, F. A.	1912–1919
Harvey, B. T.	1913–1916
Hedgecock, G. G.	1920–1921
Knaebel, E.	1920–1921
Johnson, E. L.	1905–1908
Johnson, I. M.	1920–1921
Longyear, B. O.	1913–1916
Overholts, L. O.	1914–1920
Patterson, F. W.	1916–1919
Smith, E. C.	1924
Sterling, E. B.	1898–1905
Stevens, R. H.	1898–1905
Taylor, R. M.	1916–1919
Walker, S. B.	1913–1916

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NEW MYCETOZOA FROM LONG ISLAND

Robert Hagelstein

(With Plate 26)

For the past five years the writer has been collecting and studying the Mycetozoa of Long Island, the extreme southeastern part of the State of New York and separated from the State of Connecticut by Long Island Sound. The Island is covered from end to end by the terminal moraine and glacial debris left by the last ice sheet, and the numerous kettle holes, swamps and wooded areas therein afford excellent collecting grounds, rich in many species. Several of the forms found cannot with certainty be assigned to accepted species and among them the following are believed to be sufficiently distinct to consider them as new.

Specimens from the typical fruitings have been placed in the Herbarium of The New York Botanical Garden.

Comatricha Rispaudii sp. nov.

Plasmodium? Sporangia sessile, cylindrical or clavate cylindrical, clustered in dense groups up to thirty or more sporangia, sometimes superimposed; color brown with a violet tinge; size 0.8 to 1.5 mm. high, 0.4 to 0.6 mm. thick. Sporangium wall evanescent but persisting at the base and frequently forming pseudo-cups which blend with the hypothallus. Columella dark brown, stout at the base but becoming slender, solid, sinuose and irregular, either extending to the apex or merging with the capillitium. The latter consists of branched and anastomosing brown threads spreading from all parts of the columella and generally coarsely meshed within. Spores pale violet brown, 8 to 9 μ diam., reticulated with narrow raised ridges 0.5 μ high. (Plate 26, F. 1, 2, 3.)

On dead leaves. Collected in abundance in July 1927 in a wet, wooded kettle hole of the Long Island moraine near Albertson.

Named after Mr. Joseph Rispaud, who collected the species, and who has been the constant companion of the author in the field.

Comatricha Rispaudii has some resemblance to both *Diachea caespitosa* (Sturgis) Lister and *Diachea cylindrica* Bilgram, the capillitium being very much like that in the latter species. The columella, however, is solid and not tubular, the color brown and the beautifully reticulated spores entirely different. There is no evidence of a surface net to the capillitium. It is a *Comatricha*.

Cribraria laxa sp. nov.

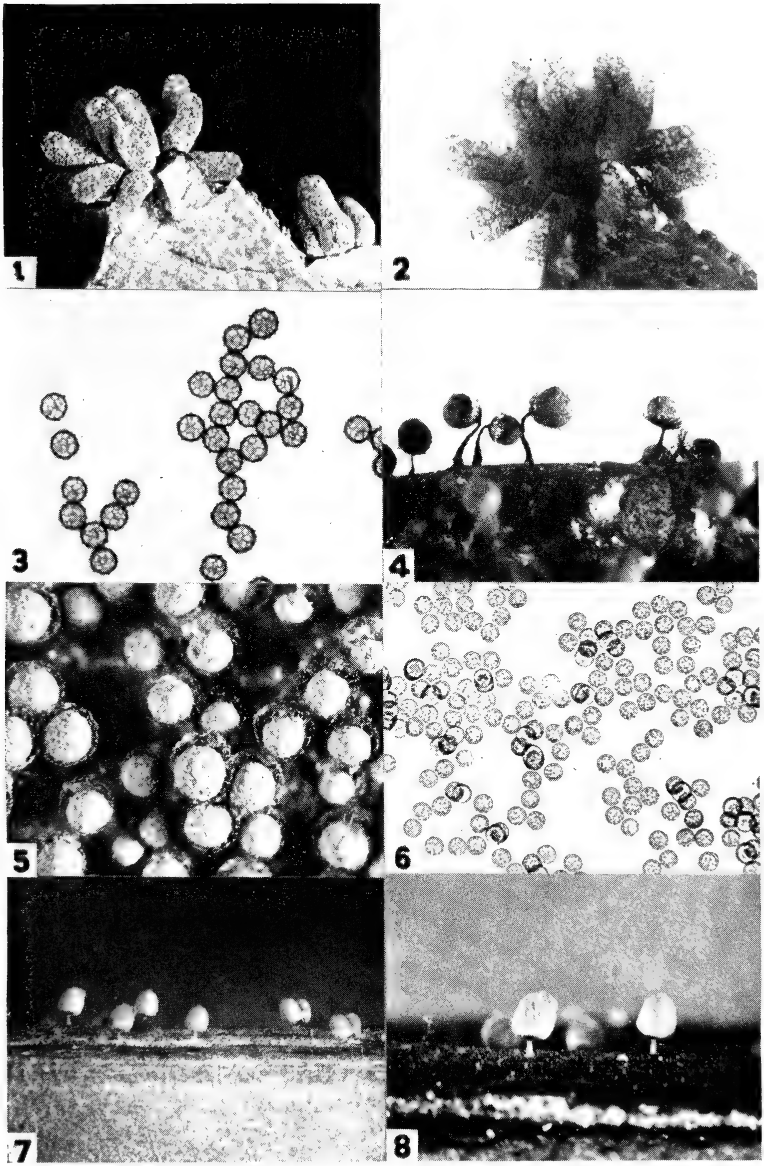
Plasmodium? Sporangia closely gregarious, stalked, globose, 0.5 to 0.7 mm. diam., nut brown; cup about one-third of the sporangium, consisting of many dark brown ribs joined near the top or connected by cross ribs and merging into the threads of the net, the ribs connected by a thin, partially evanescent membrane; net firm, regular, forming large triangular meshes 0.1 mm. or more along the sides; nodes numerous, dark brown, prominent, rounded or branching with few free rays and connected by from five to eight thin brown threads of the net. Stalk dark brown, firm, usually erect, one to two times the height of the sporangium. Spores ochraceous, distinctly warted, 6 to 7 μ diam. (PLATE 26, F. 4, 5, 6.)

On dead leaves in a kettle hole of the Long Island moraine near Albertson, August 1926 and July 1927.

This handsome species, found in the same kettle hole as *Comatricha Rispaudii*, is unusual among the species of *Cribraria* because of its habitat on leaves with the plasmodium in the substratum. During the years mentioned, a number of fruitings were collected all constant in characters and habitat. It resembles *C. intricata* in size and in the character of the well-developed net and nodes but the meshes of the net are very large; from four to nine times in area those of the latter species. The color, short stalk and cup with strong ribbing are more like those in *C. macrocarpa*. Were it not for the habitat and the large meshes of the net this form might well be considered intermediate between the other species mentioned, but a ground habitat is of great significance in the genus *Cribraria*, for the plasmodia of all other species of the genus inhabit wood only.

Arcyria insignis Kalchbr. & Cooke var. **dispersa** var. nov.

Sporangia scattered and separated, not clustered; otherwise as in normal *A. insignis*. (PLATE 26, F. 7, 8.)



Mycetozoa from Long Island

On dead grass and stalks. Jones Beach State Park, Long Island.

The locality is on the Long Island barrier beach, a narrow strip of land covered with white sand and washed by the Atlantic Ocean. During the summer of 1928 considerable quantities of *A. insignis* were collected there on decaying beach grasses close to the sand and salt water, an unusual habitat for this species. Frequently the sporangia were not clustered but solitary and scattered, a half dozen or so on a blade of grass. These latter seem to be a distinct variation due to the environment and habitat, as inland on wood the sporangia are always clustered.

MINEOLA, NEW YORK

EXPLANATION OF PLATE 26

FIG. 1. Clustered group of sporangia of *Comatricha Rispaudii*. (× 9.)

FIG. 2. The same group as Fig. 1 but blown out to show columella and capillitium. (× 12.)

FIG. 3. Spores of *Comatricha Rispaudii*. (× 450.)

FIG. 4. Sporangia of *Cribraria laxa*. (× 15.)

FIG. 5. Sporangia of *Cribraria laxa*. (× 15.)

FIG. 6. Spores of *Cribraria laxa*. (× 450.)

FIG. 7. Sporangia of *Arcyria insignis* var. *dispersa*. (× 9.)

FIG. 8. Sporangia of *Arcyria insignis* var. *dispersa*. (× 15.)

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FRANKLIN SUMNER EARLE

MYCOLOGIA

VOL. XXI NOVEMBER–DECEMBER, 1929 NO. 6

FRANKLIN SUMNER EARLE

CARLOS E. CHARDON

(WITH PLATE 27)

Professor Franklin Sumner Earle, the recognized American authority on sugar-cane technology, and one of the "oldtimers" in American mycological science, passed away after an unexpected and sudden illness at his home in Herradura, Cuba, on January 31, 1929.

He was born in Dwight, Grundy County, Illinois, on September 4, 1856, son of Parker and Melanie (Tracy) Earle. During his early youth he attended, from time to time, the University of Illinois, but received no degree. A number of years later, after he had established a reputation for himself in the fields of botany and mycology, the Alabama Polytechnic Institute bestowed on him an honorary M.S. degree.

In 1892 he entered active experimental work as superintendent of one of the branches of the Mississippi Experiment Station, but his taste for purely mycological work, which was the distinctive feature of his early life, led to his appointment, in 1895, as assistant pathologist, in charge of mycological herbarium, U. S. Department of Agriculture. A year later, he again returned to the South as Biologist and Horticulturist of the Alabama Experiment Station, and it was here that Professor Earle came into close personal touch with the eminent mycologist George F. Atkinson. During 1901–04 he was in charge of the mycological collections at the New York Botanical Garden and intensified in the study of fungi. Being himself a member of the old school, he ventured to cover too wide a field in taxonomy. Thus, while specializing

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on the Agaricales on one hand he also tried to cover such widely different groups as the tropical species of *Meliola*, the Hypocreales, the Xylariaceae, and all the groups of the Fungi Imperfecti. Nevertheless, many of his new species still hold true after having challenged the criticism of a number of subsequent students.

In 1904, Earle initiated his fruitful association with the tropics by accepting the directorship of the Estación Agronómica at Santiago de las Vegas, Cuba. A group of distinguished men of science joined with him and substantial work in practically all lines of tropical agriculture was initiated under his leadership. It was very unfortunate for Cuban agriculture that the station failed to receive the full support of the authorities and the director and his associates had to resign two years later.

For several years after, he continued in Cuba, serving as consulting agriculturist to the Cuban-American Sugar Co. and as President of the Cuba Fruit Exchange. During these years, he became thoroughly familiar with sugar cane problems. He became also engaged in various private enterprises, especially fruit-growing, but with varying success.

In 1918, the U. S. Department of Agriculture appointed him Specialist in sugar-cane culture and commissioned him to visit Porto Rico with the purpose of studying a very severe disease which was threatening to destroy the sugar industry of the island. It was Earle's leadership and perfect grasp of the situation which in a few years satisfactorily solved the control of sugar-cane mosaic. It was his famous immunity experiment at Santa Rita in 1919 in which the Uba cane proved its immunity to mosaic, and the logical study which followed, of the vast problem of cane varieties, that is responsible for the varietal revolution which during the following ten years increased Porto Rico's sugar production from 406,000 tons to 742,000 tons, with no material increase in acreage.

It was early during this period that the writer had the privilege of becoming associated with Professor Earle, at the Insular Experiment Station at Río Piedras. His tireless industry and firm grasp of the subject of sugar-cane varieties, together with his extreme modesty and fine gentleness with his co-workers, excited the admiration and recognition of all with whom he became

associated. He became a true research leader and built around himself at the Station a group of young men who were to become prominent in the sugar-cane world as sugar-cane technologists. This group of Earle's students continued true to him up to his last breath and it is with the greatest sentiment of woe and sorrow that they heard of his unexpected death.

In 1921 he again left government work and was consulting agriculturist for Central Aguirre, on the south coast of Porto Rico, and two years later with the General Sugar in Cuba. He became in 1925 associated with the Tropical Plant Research Foundation until a few months before his death.

His work in Cuba was most fruitful, although he was very often misunderstood in his recommendations. His variety work continued with the greatest intensity and the varietal collection at his Herradura farm was the most complete in the island.

During the last years of his life he worked intensively on the sugar-cane problems of Cuba, especially on cane varieties, which was his favorite subject for study since his visit to Porto Rico. The available data that he compiled, from both Cuba and Porto Rico, was amazingly large and he started writing what was to be considered as his masterpiece, his last work "Sugar Cane," which appeared a few days before his death. This excellent treatise will stand out for many years to come as the standard classic on that subject.

He was member of the American Association for the Advancement of Science, the Torrey Botanical Club, the Botanical Society of America (President in 1906), and for many years associate editor of MYCOLOGIA.

Professor Earle is survived by Mrs. Esther J. Skehan Earle, and by two daughters: Melanie Tracy (Mrs. William L. Keiser) and Ruth Esther (Mrs. David Sturrock).

DEPARTMENT OF AGRICULTURE AND LABOR,
SAN JUAN, PORTO RICO

SPECIES OF CERCOSPORA ON TRIFOLIUM, MEDICAGO, AND MELILOTUS [1]

James G. Horsfall

(With 3 Text Figures)

Recently while engaged in a study of certain meadow crop fungi, the writer encountered difficulty in assigning specific names to members of the genus *Cercospora*, occurring on legumes. This fact invited a critical examination of the organisms on various suscepts and a review of the literature to determine the status of the names which have been applied.

The work has resolved itself almost automatically into two divisions: a study of the fungi in the fresh condition on the different plants and an examination of herbarium material and literature. Since fresh specimens lend themselves to experimental comparison, the discussion of this phase will be considered first.

Examination of Fresh Material

The method which was used may be outlined briefly as follows. Fungi of the genus *Cercospora* were collected on as many of the members of *Trifolium*, *Medicago*, and *Melilotus* as possible in the field. They were brought into the laboratory where 100 conidia were measured from a water mount and a few of the typical ones were sketched with a camera lucida. Cultures were made from single conidia. A few leaves were boiled in KOH, dehydrated, and mounted permanently in balsam for future study of the conidiophores. The symptomatology was carefully described for each suscept and compared with others.

The results of this study led the writer to conclude that the fungus occurring on *Trifolium agrarium* L., *T. hybridum* L., *T.*

[1] Also presented to the Faculty of the Graduate School of Cornell University, February, 1929, as a minor thesis in partial fulfillment of the requirements for the Degree of Doctor of Philosophy.

Acknowledgment. The work was prosecuted under the helpful direction of Dr. H. M. Fitzpatrick to whom the writer desires to express appreciation. Dr. Charles Chupp also rendered valuable assistance during the investigation. Mr. W. R. Fisher made the photographs.

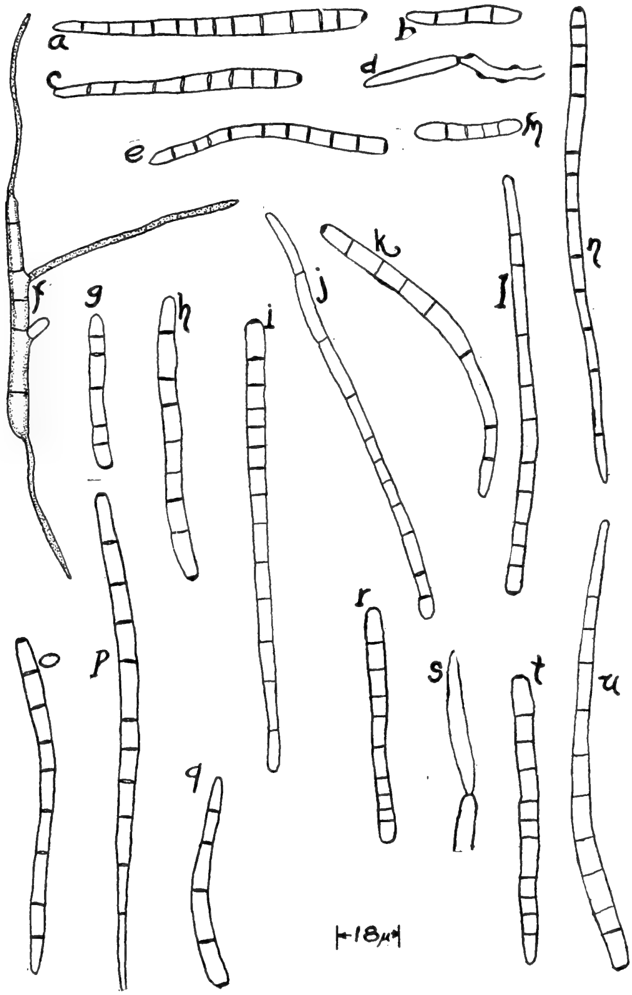

FIG. 1. Showing typical conidia of *Cercospora zebrina* Pass. from various plants. Sketched in the fresh condition with the aid of a camera lucida. *a*, *b*, *c*, and *e*, conidia; *d*, formation of a conidium terminally on conidiophore; *f*, germination of conidium. All from *Trifolium hybridum*. *g* and *h*, conidia from *Trifolium repens; i*, *j*, *k*, *l*, and *m*, conidia from *Medicago lupulina; n*, conidium from *Trifolium pratense; o*, *p*, and *q*, conidia from *Melilotus alba; r*, *t*, and *u*, conidia; *s*, formation of a conidium. All from *Trifolium agrarium*.

pratense L., *T. repens* L., *Medicago lupulina* L., *M. sativa* L., and *Melilotus alba* Desr. constitutes one species. The evidence which indicates this is presented below.

Conidial characters. Spore measurements appear to mean but little in the genus, *Cercospora.* For example the conidia and conidiophores grow much longer when the fungus fruits under conditions of high humidity as opposed to conditions of drought. Welles (**5**) showed that the fungus structures of *Cercospora* are larger when moisture is abundant. He says also, "It may be seen readily that the sizes of the fruiting structures, induced through artificial inoculation, vary greatly, depending upon the host." Back in 1892 Atkinson arrived at the same conclusions from observational evidence (**1**). He says (pp. 3–7), "The specific differences of the various hosts as well as the structural variations of their leaves, the differences in texture, thickness and the varying power which the different species possess through their vital processes to resist the growth of the parasite, all exert a powerful influence upon its form and characteristics." The results of the measurement of 100 conidia in the fresh condition in a water mount are summarized in the table.

SUMMARY OF THE MEASUREMENTS OF 100 CONIDIA OF CERCOSPORA ON VARIOUS LEGUMES

Suscept	Variation		Mean length μ
	Length μ	Width μ	
Trifolium agrarium	36.0–140.4	4.0–6.0	82.12±0.82
Trifolium hybridum	21.6–149.4	3.6–5.4	66.98±2.08
Trifolium pratense	37.8–140.4	3.6–5.4	82.71±1.91
Trifolium repens	27.0–120.6	1.8–6.2	63.86±1.50
Medicago lupulina	30.6–180.0	3.6–5.4	87.49±3.58
Melilotus alba	34.2–117.0	3.6–6.0	69.23±1.32

It appears very obvious from this table that the spore size, especially length, fluctuates within wide limits. All the lengths with a single exception fall within the variation recorded for *Trifolium hybridum,* 21.6–149.4 μ. One spore from *Medicago lupulina* was 180 μ long. The variation in width is less, being between 1.8 and 6.2 μ. This would be expected since the ratio between length and width is so large that a big fluctuation in

length would hardly be measurable in width even if the two varied directly. The variation of the means is so small that it has no value in specific separation. Since the fungi on the various plants are not readily separable on the basis of spore length, it seems hardly desirable to resort to the measurement of 100 conidia to differentiate them. Spore measurements therefore indicate that only one species is involved. The differences between the means may be due to the presence of "strains" of the fungus, but they may be explained as readily on the basis of environmental effects.

The conidia collected on all plants are hyaline, many-septate, and cylindrical to attenuate above. The camera lucida sketches reproduced in figure 1 show the marked similarity of the spores from different sources.

Conidiophore characters. The conidiophores vary in length like the conidia, being governed apparently by the same conditions. They are amphigenous, light brown in color, sparsely septate, and usually geniculate. In all cases continuous or non-geniculate conidiophores can be found, but a search invariably reveals septa and geniculations in some of the conidiophores. The conidiophores seem to become septate and geniculate with age. The latter character is dependent upon the number of spores which have been produced on each conidiophore. The conidiophores arise from a small stroma which in any case contains but few more cells than the basal cells of the conidiophores. Some typical conidiophores sketched with the aid of the camera lucida are illustrated in figure 2, but these are from herbarium material.

Cultural characters. Cultures from single conidia from all the suscepts listed in the table are remarkably alike under identical conditions. Only a small amount of aerial mycelium is produced. The submerged growth is dull greenish black grading outward to a dark ivy green or vetiver green (Ridgway (**4**)).

Symptomatological characters. The shape and color of the lesions on the various plants lend some support to the theory that the diseases on them are identical. The spots on red clover leaves illustrated in figure 3 and those on hop clover may be said to be typical since they present the striped aspect from which the specific name, *zebrina*, derives its name. They are linear and

fairly sharply delimited. Terminal lesions on leaflets are triangular, being limited on either side by veins from the midrib. The elongated spots on red clover are in contrast with the almost circular spots on sweet clover, but all intergrading conditions exist on the other plants. Lesions on sweet clover leaves may reach five millimeters in diameter. As a rule alfalfa leaves bear smaller spots of the same general shape, but in one case the linear

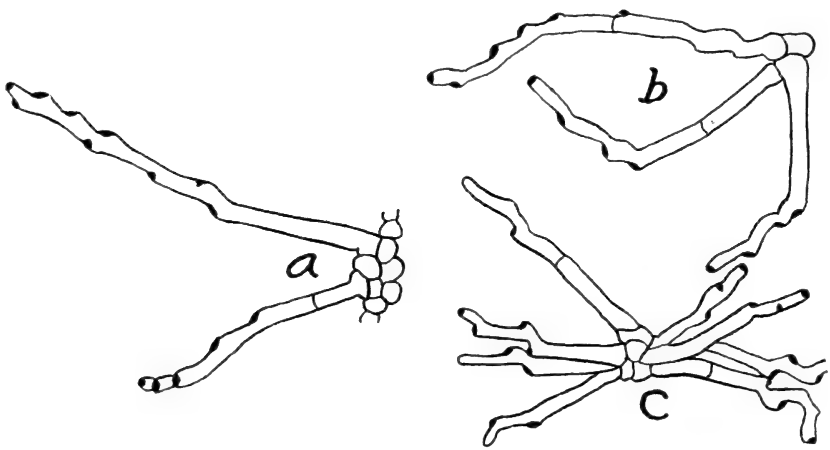

FIG. 2. Showing typical conidiophores of *Cercospora zebrina* Pass. on different plants. Scale same as in figure 1. *a*, from type material of *Cercospora zebrina* Pass. as distributed by Rabenhorst in Fungi Europaei, no. *2277*, on *Trifolium medium; b*, from material of *Cercospora Medicaginis* Ellis & Ev. as distributed by Ellis and Everhart in Fungi Columbiani, no. *2314*, on *Medicago sativa; c*, from material of *Cercospora Davisii* Ellis & Ev. as distributed by Ellis and Everhart in Fungi Columbiani, no. *1811*, on *Melilotus alba*.

spots were seen on secondary shoots developing under moist conditions. It appears then that atmospheric conditions and the type of tissue influence the shape of the spot. The spots on alsike clover, white clover, and yellow trefoil are intermediate between the circular ones on sweet clover and the linear ones on red clover. These spots are limited by veins to a large extent and are elongate but not sufficiently to form definitely linear spots as illustrated in figure 3.

Although the color of the lesions varies considerably, in general it is reddish or smoky brown. Color comparisons with

Ridgway gave the following for the various plants: chocolate or warm sepia on sweet clover; olive brown to wood brown on hop clover; deep brownish drab, light seal brown, and Hay's brown on yellow trefoil; bister, seal brown, bone brown and clove brown on red clover; Rood's brown and Prout's brown on alsike clover; burnt umber, warm sepia, chocolate, and sepia on white clover. The agreement of color symptoms on many of the suscepts suggests the identity of the diseases. Not only the shape but also the color of the spots on white clover are intermediate between those on sweet clover and red clover. Warm sepia and chocolate are common to the spots on white and sweet clover, while bister is common to the spots on white and red clovers. Light seal brown is common to the spots on yellow trefoil and red clover. The disease occurs on stems and petioles as somewhat shrunken lesions with colors similar to the lesions found on leaves.

EXAMINATION OF LITERATURE AND EXSICCATI

A search through the literature revealed six species of *Cercospora* described on members of the genera *Trifolium*, *Medicago*, and *Melilotus*. The original descriptions of all species were obtained and compared with each other. Except for *C. Meliloti* there appeared to be no essential differences between them.

Type material of all the species except *C. Meliloti* (Lasch) Oud. and *C. helvola* Sacc. has been available for study. However, Saccardo's drawings of the type of the latter have served for comparison. The writer is indebted to Dr. F. J. Seaver for permission to examine the types of *C. Davisii* Ellis & Ev. and *C. Medicaginis* Ellis & Ev. deposited in the Herbarium of the New York Botanical Garden and labelled in the handwriting of Ellis. Professor Irmscher of the Institut für Allgemeine Botanik und Botanischer Garten, Hamburgische Universität, sent for study a portion of the type of *Cercospora Stolziana* Magnus.

A critical examination of all the type materials gave precisely the same results obtained in studying field collections on the different plants. The conidia of all are hyaline, many-septate, quite variable in length, and obclavate or cylindrical. Conidiophores from all the specimens are of the same brown color, sparsely septate to continuous, sometimes geniculate, caespitose,

and borne on a limited stroma of the same color. *C. Medicaginis* and *C. zebrina* are stated to have continuous conidiophores, but the type material shows a few cross walls. *C. Stolziana* is said to differ from *C. helvola* and *C. zebrina* in the character of the spots, which are supposed to be somewhat blistered, but the type specimen sent to the writer bears spots which are identical in the dried condition with those collected on *T. repens* in New York as illustrated in figure 3. Welles (p. 216) says, "It has

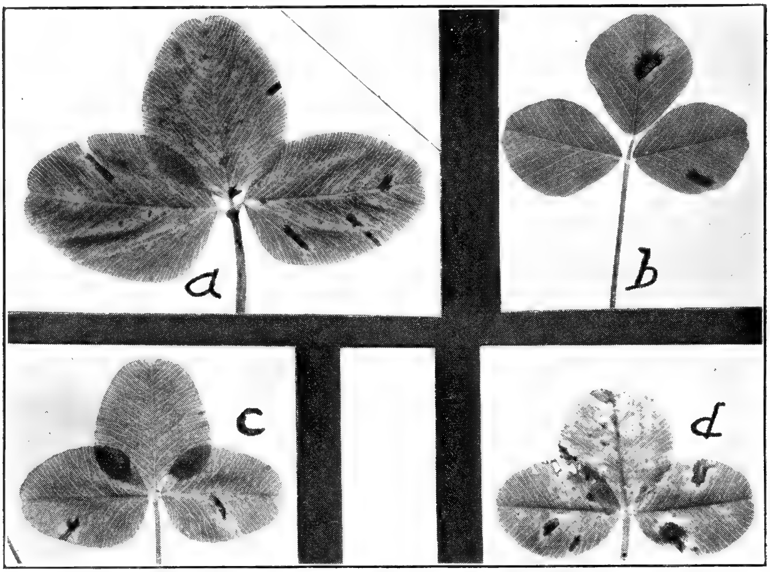

FIG. 3. Showing lesions caused by *Cercospora zebrina* Pass. on different plants. Note the striped or zebrine aspect. Natural size. *a*, on *Trifolium pratense*. Note petiole lesion. *b*, on *Medicago lupulina*. *c*, on *Trifolium hybridum*. *d*, on *Trifolium repens*.

been shown that the same organism through its stimulation brings about different reactions on plants which are not widely separated in their general make-up and relationship." It would appear then that a slight difference in the character of the spots even if it existed would be insufficient grounds for delimiting species. The spot really is a reaction on the part of the plant to the presence of the pathogene and is not an attribute of the fungus itself.

Cercospora Meliloti (Lasch) Oud. occupies a doubtful position.

Ellis has written on the packet of type material of *C. Davisii* in the Herbarium of the New York Botanical Garden that he sent some of it to Oudemans, who pronounced it different from his *C. Meliloti*. Oudemans' discussion of *C. Meliloti* is somewhat vague. He says (**3**) that the diseased leaves present blanched orbicular spots, oval to oblong and 2 to 4 millimeters in diameter. Black bodies resembling perithecia are scattered over these. He says superficial examination of these "quasi-perithecia" shows them to have a ragged opening, but a more careful examination shows that this is an opening in the epidermis of the leaf which allows the hyphae of the *Cercospora* to be protruded. Oudemans lists *Depazea Meliloti* Lasch as a synonym and bases *C. Meliloti* upon the specimen to which *D. Meliloti* had been applied. Saccardo (Sylloge Fungorum **10**: 362) placed *D. Meliloti* in *Septoria*. Lindau (**2**) states that he is in doubt as to the synonymy of *D. Meliloti* and *C. Meliloti*, but feels that it is possible "dass beide Pilze genetische in Zusammenhang ständen." It seems unwise in view of these facts and in the absence of type material to place *C. Meliloti* definitely in this scheme. It does appear from the description to be different from the other fungi on species of the genera in question.

Since all the evidence at hand indicates that only one fungus occurs on species of *Trifolium*, *Medicago*, and *Melilotus* except for the possible exception of *C. Meliloti*, all the names are cast into synonymy. *Cercospora zebrina* Pass., being the oldest name applied, must be used to denote this fungus.

CERCOSPORA ZEBRINA Pass. Hedwigia **16**: 124. 1877.

Cercospora helvola Sacc. Fungi Ital. *pl. 667*. 1881.

Cercospora Davisii Ellis & Ev. Proc. Acad. Nat. Sci. Phila. **43**: 89. 1891.

Cercospora Medicaginis Ellis & Ev. Proc. Acad. Nat. Sci. Phila. **43**: 91. 1891.

Cercospora Stolziana Magnus, Flora Tirol **3**: 558. 1905.

Spots amphigenous, dark brown, suborbicular to linear on leaves sometimes limited by veins; conidiophores amphigenous, light brown, erect, caespitose to scattered on a limited stroma, geniculate or shouldered, continuous, then sparsely septate, 20–80 $\times$ 3–5 μ; conidia hyaline, oblong-cylindrical to attenuate above, becoming multiseptate, 21.6–180.0 $\times$ 1.8–6.2 μ.

Habitat: On leaves, stems, and petioles of *Medicago arabica*, *M. maculata*, *M. hispida*, *M. lupulina*, *M. sativa*, *Melilotus alba*, *Trifolium agrarium*, *T. alpestre*, *T. hybridum*, *T. incarnatum*, *T. medium*, *T. pratense*, and *T. repens*.

Material examined under names listed:

Cercospora Davisii Ellis & Ev., *type*, Herb. N. Y. Bot. Gard. and Fungi Columbiani no. *1811*, on *Melilotus alba*.

Cercospora helvola Sacc., *type*, a drawing.

Cercospora Medicaginis Ellis & Ev., *type*, Herb. N. Y. Bot. Gard. and Fungi Columbiani no. *2314*, on *Medicago sativa;* Dearness as identified by Ellis, Herb. N. Y. Bot. Gard., and Fungi Columbiani no. *3209*, on *M. lupulina*.

Cercospora Stolziana Magnus, *type*, Herb. Hamburgische Universität, on *Trifolium repens*.

Cercospora zebrina Pass., *type*, Fungi Europaei no. *2277*, on *Trifolium medium;* Fungi Columbiani no. *461*, on *T. agrarium*, and no. *4709*, on *T. pratense;* Fungi Saxonici no. *1497*, on *T. medium;* Fungi Wisconsinenses no. *145*, on *T. repens;* Herb. Dept. Pl. Path. Cornell University no. *5843*, on *T. agrarium*, no. *17013*, on *T. hybridum*, no. *17052*, on *T. repens*, no. *17309*, on *T. pratense*, no. *17051*, on *Medicago lupulina*, no. *17446*, on *M. sativa*, no. *17447*, on *Melilotus alba;* Herb. James G. Horsfall no. *318* and *319*, on *Medicago hispida*.

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BOTRYOSPHAERIA AND PHYSALOSPORA IN THE HAWAIIAN ISLANDS

Neil E. Stevens and C. L. Shear

(With 1 Text Figure)

The collection of Hawaiian fungi, of which the material discussed in this paper forms a part, was made by the writers during the winter of 1927–1928. The work was financed chiefly by the United States Department of Agriculture; assistance was also given by the Pan Pacific Research Council. We were aided in our work in one way or another by representatives of every scientific institution in the Islands, indeed, by almost every botanist. It would be a pleasure to acknowledge the assistance thus rendered by mentioning each of these friends, but the list would be a long one and could be more conveniently obtained by referring to a list of the members of the Botanical Society of Hawaii. Several years will, of course, be needed for working up the large quantity of fungi collected, even though many specimens have been referred to various specialists. It consequently seems wise to publish parts of the work as completed and to summarize with a final list.

The present paper discusses the two genera *Botryosphaeria* and *Physalospora*, which were worked up first because they are being actively studied in other parts of the United States. This material, while limited, has interest as bearing on the distribution and occurrence of fungi in the Islands. Fungi of these two genera are apparently not abundant. The numerous reports of *Diplodia* (under a variety of specific names) causing diseases of tropical hosts and our own interest in the group led the writers to devote especial attention to the occurrence of these fungi in the territory. In fact, one of us devoted most of his energies to searching for good material of these two genera on different hosts. The results were disappointing. In all we are able to list less than thirty collections with well developed, viable ascospores. A single day's

collecting in Florida or Georgia has sometimes yielded more good material of these two genera than the entire season in the Hawaiian Islands. As another indication of the relative scarcity of these genera it may be noted that F. L. Stevens, in his extensive collection of fungi in the Hawaiian Islands, reports the finding of only one species of *Sphaeropsis*, *S. Gouldiae*, and only one previous record of a *Diplodia*.

BOTRYOSPHAERIA RIBIS CHROMOGENA

The most abundant of any fungus belonging to this group was *Botryosphaeria Ribis chromogena* Shear, Stevens & Wilcox, of which we obtained nineteen collections with viable ascospores on the following hosts:

Acalypha sp.	*Pandanus odoratissimus* L. fil. (Fruits)
Aleurites moluccana Willd.	*Pipturus albidus* A. Gray
Eucalyptus sp.	*Psidium Guajava* L.
Hibiscus Sabdariffa L.	*Ricinus communis* L.
Hibiscus tiliaceus L.	*Schinus molle* L.
Leucaena glauca Benth.	*Schinus terebinthifolius* Raddi.
Mangifera indica L.	*Wikstroemia phillyreaefolia* A. Gray

From fifteen of these collections pycnospores have been produced in culture from single ascospores. Spore measurements are as follows: Ascospores: 14–28 $\mu \times$ 5–11 μ; mostly 21–23 $\mu \times$ 8–9 μ; Pycnospores: 16–27 $\mu \times$ 4–7 μ; mostly 18–22 $\mu \times$ 5–6 μ. These, as will be observed, correspond well with the measurements (Ascospores: 13–28 $\mu \times$ 4–12 μ and Pycnospores: 10–29 $\mu \times$ 4–9 μ) for *Botryosphaeria Ribis* as found in the United States [(**5**) p. 101 and (**6**) p. 594]. Moreover, cultures of all of these nineteen collections produced, when grown on cornmeal in flasks, the pink coloration typical of the currant cane blight and, finally, five selected at random produced the typical cane blight when inoculated in currant plants at East Falls Church, Va., during the spring of 1928. There seems to be, then, no doubt of the identity of this Hawaiian material with the currant cane blight of the eastern United States.

The known range of this fungus has been greatly extended during the last five years. The disease of currant canes it causes has been known for more than thirty years. The fungus itself

was carefully described by Grossenbacher and Duggar (**2**) from currants in 1911. The first report of this fungus on a host other than currant was made by Stevens and Jenkins (**11**) in 1924. They reported it on horsechestnut and rose. Shortly afterwards, Fenner (**1**) found the fungus producing a rot of apples in several locations in the eastern United States. During 1924 (**8**) this fungus was found on numerous hosts, many of them native, in Georgia and Florida, and once in Cuba. The present record extends the range to include the Hawaiian Islands. The wide distribution of this fungus, together with the fact that it has been found on apples in the United States, lends further confirmation to the suggestion made in 1924 (**6**, p. 595) that the fungus described by Putterill (**4**) from South Africa on apple is identical with the *Botryosphaeria Ribis chromogena*.

PHYSALOSPORA FUSCA

This distinct species was obtained four times on the following hosts:

Acalypha sp.
Hibiscus tiliaceus L.
Lantana aculeata L.
Wikstroemia phillyreaefolia A. Gray

Although hitherto known only from a few collections in western Cuba (**9**) and found but four times in our Hawaiian collections, it seems reasonable to suspect that this fungus may in time be found generally distributed throughout the tropics. Ascospore measurements of Hawaiian material are 30–39 $\mu \times$ 13–19 μ; mostly 33–35 $\mu \times$ 14–15 μ; of the Cuban material hitherto described (**9**, p. 207) 29–37 $\mu \times$ 11–16 μ.

PHYSALOSPORA MALORUM ON OSTEOMELES

Perhaps the most interesting of all our finds in this group was a fungus which appears to be a form of *Physalospora malorum* (Peck) Shear. But three collections of this fungus were made, all on *Osteomeles anthyllidifolia* Lindl., in the Kona region of Hawaii. The host, called "Uulei" by the natives, is endemic, belongs to the Rosaceae, and is found as a small tree in the Kona region. The wood of this species is said to have been used by the Hawaiian

chiefs for the bows which they used in the sport of shooting the native Hawaiian rat.

The ascospores of this fungus—28–35 $\mu \times$ 10–15 μ; mostly 31–33 $\mu \times$ 10–12 μ—are well within the range of *Physalospora malorum* (5) as found in the eastern United States, 18–40 $\mu \times$ 6–16 μ. The pycnospores, however, measured 23–39 $\mu \times$ 10–14 μ; mostly

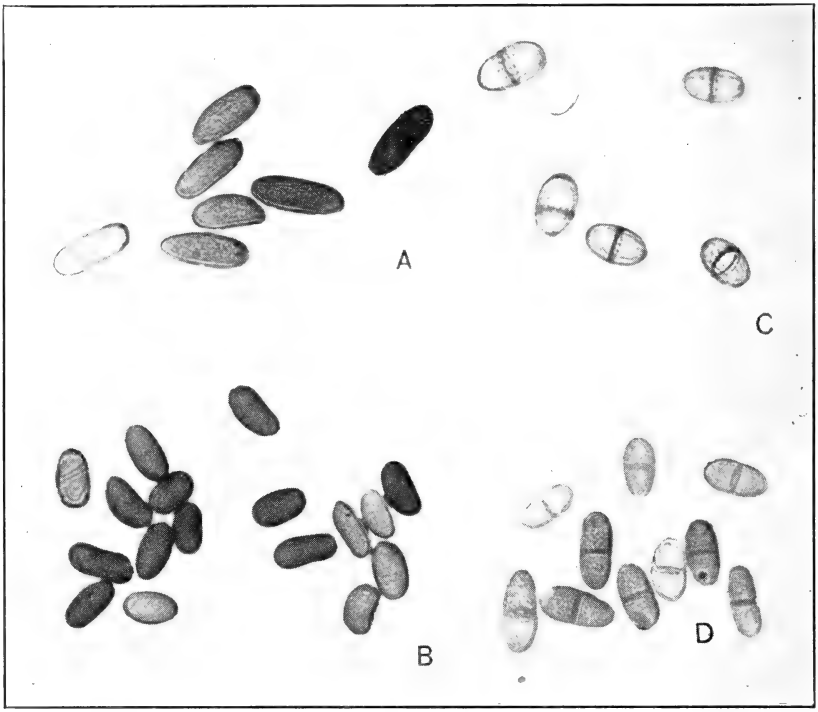

FIG. 1. *A*, *Physalospora malorum*, pycnospores produced in pure culture from ascospores. Spec. no. *1164*, on *Ostiomeles*, $\times$ 400; *B*, pycnospores of the type usually referred to as *D. natalensis*, produced in pure culture from pycnospores. Spec. no. *1196* on *Hibiscus*, $\times$ 400; *C*, pycnospores produced in pure culture from pycnospores on *Prosepus* sp. may be either a small form or *P. malorum* identical with *Sphaeropsis Gouldiae*, $\times$ 400; *D*, pycnospores produced in pure culture from pycnospores on *Prosopis* sp. This type seems to agree most closely with *S. malorum* of Berkeley and not with the form common in the eastern United States. $\times$ 400.

30–33 $\mu \times$ 11–12 μ. While most of the pycnospores of the fungus on Osteomeles fall within the range of pycnospores for this species (10), p. 336, 17–33 $\mu \times$ 7–15 μ, they are much above the mean in

length. Their general appearance, however, is identical with that of pycnospores of *Physalospora malorum* as commonly found in the eastern United States, uniformly brown in color and almost always one-celled. There appears, therefore, to be no sufficient reason at this time for considering this fungus distinct from *P. malorum*, especially in view of the fact that pycnospores of *P. malorum* are decidedly variable in size and some strains with unusually large pycnospores have been described even on apple (**12**).

PYCNIDIAL FORMS

It seems surprising to us that no ascospore material was obtained from which was developed the pycnidial form so often reported in the tropics and which is often called *Diplodia natalensis* or *Botryodiplodia Theobromae.* This pycnidial form itself seems to be rare in Hawaii. Only four collections, three on *Hibiscus tiliaceus* L. and one on *Panax* sp., were made which correspond to "*D. natalensis*" morphologically, and of these only No. 1148 on *Hibiscus* had the characteristic often associated with cultures of this species, that of being able to grow in culture at 36° C. (**9**, p. 215). The spore measurements of this material were: pycnospores produced in culture, 20–37 $\mu \times$ 10–17 μ; mostly 21–26 $\mu \times$ 12–14 μ.

Two other pycnidial forms were found and may be briefly described, although no specific names will be assigned. Three collections were made—one each on *Leucaena glauca*, *Nerium Oleander*, and *Prosopis* of a fungus, with brown one-celled pycnospores, size 17–23 $\mu \times$ 9–14 μ; mostly 18–21 $\mu \times$ 9–12 μ. This may, perhaps, be considered a small form of *P. malorum* and is possibly identical with *S. Gouldiae* Stevens and Plunkett (**7**, p. 136).

Two collections, one on *Gossypium* and one on *Prosopis*, have brown septate pycnospores with spore measurements as follows: 20–27 $\mu \times$ 9–12 μ; mostly 21–23 $\mu \times$ 10 μ. This more nearly resembles what we consider typical material of *P. malorum* of Berkeley, common in Europe and found in the northwestern part of the United States.

DISTRIBUTION OF BOTRYOSPHAERIA AND PHYSALOSPORA IN THE HAWAIIAN ISLANDS

As already noted, our collections are so scant as to indicate that fungi of these genera are not abundant in the territory of Hawaii. One important factor may be the lack of cut brush. Fungi of these genera fruit most abundantly on branches which have been cut while still living and left for a number of months. Such brush is abundant in the southeastern United States but relatively rare in the territory of Hawaii, partly because of a habit of neatness, which makes a yard man a conventional part of the equipment of every complete household.

The distribution of these fungi on the larger Islands suggests that the peculiar climatic conditions may not be favorable to their growth and spore production. In the "rain forest" of the Islands these fungi are rarely found. Indeed, in the "rain forest," fungi of any kind are rare. This seems to be true in other tropical countries. The drier portions where, except for irrigation, practically desert conditions exist, are also unfavorable to both these genera. The only places where they are even relatively abundant are the regions which are dry except for abundant tropical showers and the transition zones between the wet and dry portions, about where irrigation begins. An alternation of relatively short wet and dry periods is, of course, the normal condition in the southeastern United States, where we have collected these fungi so extensively and find them so abundant.

It will be noted that most of the specimens reported are on host plants which were introduced early by man and are now widely distributed in the Islands and especially in regions where the climatic conditions for the development of these fungi seem favorable. Of the native hosts the following are regarded as endemic by Hillebrand (**3**): *Pandanus, Pipturus, Osteomeles, Wikstroemia*. Of these *Pipturus* is frequently found associated with the introduced plants bearing these fungi. The specimens on *Wikstroemia* were found on the slopes of Manua Loa with none of the introduced hosts observed in the vicinity. The material on *Osteomeles* presents the most interesting case as it is an endemic host bearing a form of *Physalospora* not found on any

other host in the Islands. We might, perhaps, be justified in supposing this to be a native fungus.

In connection with the discussion of the distribution of these fungi on native hosts, it should be mentioned that the "Ohia lehua" of the natives, *Metrosideros polymorpha* Gaud., is the most generally distributed and abundant tree found on all the Islands in those regions where these fungi were chiefly found; but, notwithstanding a thorough search of this host, not a single specimen of any of the fungi discussed in this paper was found. It may be that cut branches of certain hosts furnish more favorable substrata for the development of these fungi than others and this may be a factor in determining the abundance and distribution of these fungi on native hosts. The behavior of these fungi in the eastern United States seems to indicate very little host preference as they have been found on a large number of woody hosts in the southern States. *Diaporthe* species are apparently competitors for the possession of cut or dying branches and species of this genus were much more abundant on the hosts mentioned than *Physalospora* and *Botryosphaeria*. This is also true to a considerable extent in southern Florida.

It will be noted that all the fungi mentioned in this paper are considered to be either identical with or very closely related to those already known from other parts of the world. In this connection, it should be remembered that a very large part of the flora of the Islands is made up of introduced plants, many of which are very widely distributed. It will, then, not be surprising if a very large number of the fungi found in the Hawaiian Islands prove to be of relatively recent introduction.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

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THE LONGEVITY OF MYXOMYCETE SPORES

Ernest C. Smith

(With Plate 28)

The longevity of myxomycete spores is a subject which has received little attention. One searches the literature in vain for definite and specific information as to the length of time such spores retain the power of germination. Lister simply states that, if kept dry, the spores retain their vitality for several years. While there is difficulty in securing germination of the spores of some species, whatever the age, workers find the mature spores of many species quite viable at the end of two or even three years. Data for the viability of spores of greater age are conspicuously lacking.

The writer of this article, in connection with other investigations, left some ten-year-old spores in a hanging drop culture and after five days noted with surprise that germination had taken place. This led to further investigation of the viability of spores of known ages from four to nearly thirty-two years. In every case germination was secured and in some cultures the percentage of viable spores was quite as great as in cultures where the spores were less than a year old. The elapsed time between wetting of the spores and the observed emergence of the swarm-cells was somewhat greater than with younger spores, but the following development was regular in all the species tested—loss of flagellum, cell division, sometimes repeated several times, fusion of myxamoebae and formation of small plasmodia.

The definite data on the germination of these aged spores are contained in the following table.

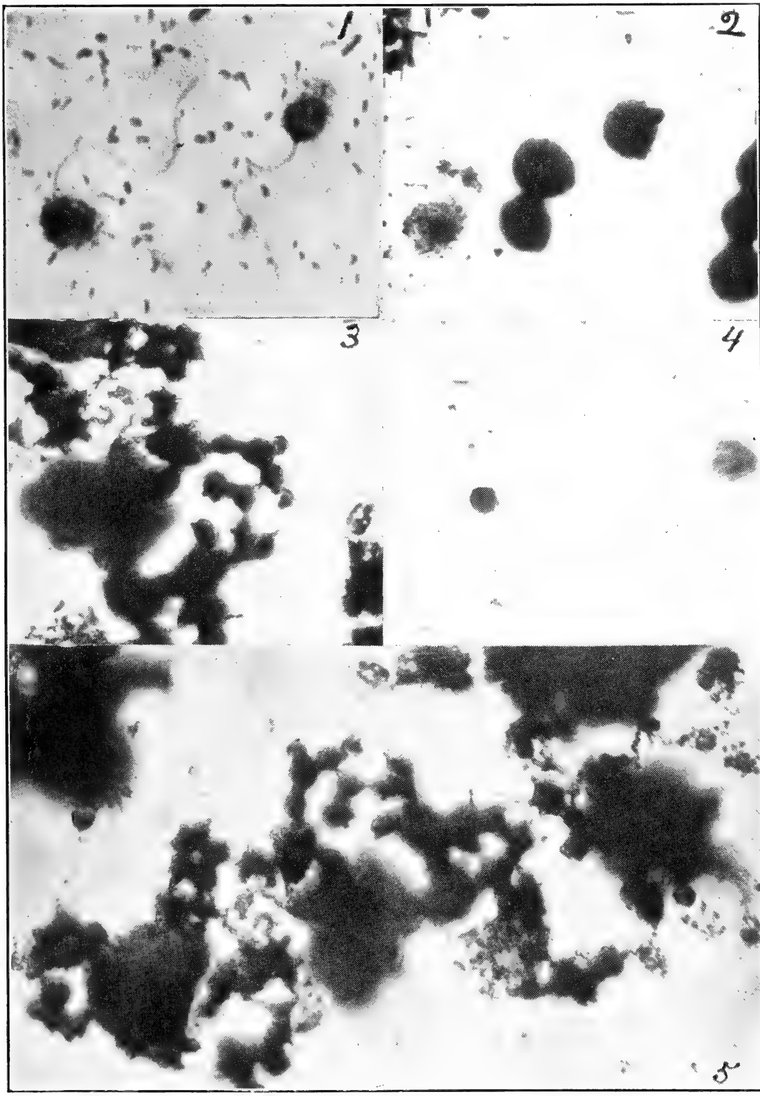
The elapsed time between the wetting of the spores and the observation of germination is not significant, as observations were sometimes twenty-four hours apart and in a few cases germination was well advanced when first observed. Some of these aged spores were received from Dr. Jahn in Germany; the oldest were collected in Michigan by Prof. B. O. Longyear of our Forestry department.

Within the limits of the investigation it is clear that the age of the spores is not a very important factor in germination. The spores of certain species, when less than a year old, show a very small percentage of germination, while those of other species

Species	Collected	Wetted	Germinated
Stemonitis flavogenita Jahn	July, 1924	March, 1929	18 hrs.
Fuligo septica (L.) Gmel.	July, 1923	March, 1929	3 das.
Reticularia Lycoperdon Bull.	June, 1919	March, 1929	30 hrs.
Lamproderma violaceum (Fries) Rost.	July, 1916	March, 1929	48 hrs.
Trichia favoginea (Batsch) Pers.	March, 1913	March, 1929	43 hrs.
Enteridium olivaceum Ehrenb.	Oct., 1912	April, 1929	54 hrs.
Badhamia utricularis (Bull.) Berk.	Oct., 1909	March, 1929	44 hrs.
Stemonitis ferruginea Ehrenb.	June, 1908	March, 1929	42 hrs.
Dictydiaethalium plumbeum (Schum.) Rost.	1907	March, 1929	66 hrs.
Badhamia panicea (Fries) Rost.	1906	March, 1929	68 hrs.
Trichia Botrytis Pers.	Oct., 1903	March, 1929	42 hrs.
Lepidoderma tigrinum (Schrad.) Rost.	Oct., 1903	March, 1929	52 hrs.
Physarum straminipes Lister	1903	April, 1929	72 hrs.
Trichia scabra Rost.	Aug., 1902	April, 1929	72 hrs.
Trichia lateritia Ler.	Nov., 1901	April, 1929	48 hrs.
Physarum cinereum (Batsch.) Pers.	May, 1900	March, 1929	40 hrs.
Didymium squamulosum Fries	June, 1899	April, 1929	72 hrs.
Fuligo septica (L.) Gmel.	June, 1899	April, 1929	72 hrs.
Diachaea leucopoda Rost.	June, 1899	April, 1929	46 hrs.
Hemitrichia clavata Rost.	July, 1897	April, 1929	66 hrs.
Stemonitis ferruginea Ehrenb.	June, 1897	April, 1929	48 hrs.

show very great variations in germination even when taken from sporangia collected at one time and place. These phenomena are repeated in the aged spores. One very evident cause of variation is difference in maturity of spores at time of collecting, a difference which in some cases clearly extends to different spores in the same sporangium. As all spores were cultured under identical conditions other causes for small percentage of germination in certain species may be in different optimum temperatures or pH values.

The investigation was limited by the material immediately at hand. Almost certainly such uniform results would not be reached with all species. Yet the fact that the species tested come from widely separated groups suggests that we are here dealing with a phenomenon which is not exceptional, but fairly general. At the least, we have an additional instance of the remarkable vitality and protective adaptability of the organisms



MYXOMYCETE SPORES

of this group which, during so large a part of their life cycle, consist of naked protoplasm. We see that this extraordinary vitality of the spores is in direct line with the power of the swarm-cells and young plasmodia to form cysts and of the older plasmodia to form sclerotia, resting stages with thick protecting walls, from which, under favorable circumstances, they return to their previous appearance and functions. The limits of these resting stages have never been precisely determined, though Jahn has done both extensive and intensive work on the age phenomena of sclerotia. The organisms of this group, by common consent not in the direct line of organic evolution, seem to have preserved primitive characteristics of adaptability and tenacity which make them a fascinating field for the study of the inherent qualities of protoplasm.

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EXPLANATION OF PLATE 28

Fig. 1. Swarm-cells from spores of *Reticularia Lycoperdon* collected in June, 1919, germinated in March, 1929. × 1000.

Fig. 2. Swarm-cells (one emerging from spore) from spores of *Dictydiaethalium plumbeum* collected in 1907, germinated in March, 1929. × 1000.

Fig. 3. Swarm-cells of *Lepidoderma tigrinum* emerging from spores collected in October, 1903, germinated in March, 1929. × 600.

Fig. 4. Swarm-cells and amoeba from spores of *Physarum cinereum* collected in 1900, germinated in March, 1929. × 1000.

Fig. 5. The field of which No. 3 is a portion.

These figures are microphotographs.

THE LARGE LEAF SPOT OF CHESTNUT AND OAK ASSOCIATED WITH MONOCHAETIA DESMAZIERII

George Grant Hedgcock

Arthur H. Graves[1] in 1912 described a leaf disease of chestnut and oak and ascribed it to *Monochaetia Desmazierii*. This disease is characterized by large, more or less circular, leaf spots with concentric zones of varying gray, yellow, and brown. These spots vary in size, but frequently attain the diameter of one inch. Graves reported the disease on *Castanea dentata* in Virginia, North Carolina, and Georgia, and on *Quercus borealis maxima* in North Carolina.

The writer has had this disease under observation since 1912 and finds that it occasionally causes considerable injury to the foliage of trees. The injury, however, usually occurs late in summer after the trees have made their growth, which no doubt greatly lessens the effect on the trees. *Monochaetia Desmazierii* is constantly present on the leaf spots caused by this disease, but its parasitism has never been proven.

In order to show the range of this disease and of *Monochaetia Desmazierii*, the states from which specimens have been collected are given, which are as follows:

On *Acer rubrum*[2] in Georgia, North Carolina, and Tennessee.

On *Castanea dentata* in Georgia, Indiana, North Carolina, Tennessee, and Virginia.

On *Hamamelis virginiana* in Georgia, Maryland, Tennessee, and Virginia.

On *Hicoria alba* in Tennessee.

On *H. glabra* in Maryland.

On *H. laciniosa* in North Carolina.

[1] Graves, A. H. The large leaf spot of chestnut and oak. Mycologia **4** 170–174, pl. 69, fig. 1, 1912.

[2] The nomenclature used for trees is that of Geo. B. Sudworth in "Check List of the Forest Trees of the United States, their Names and Ranges," U. S. Dept. Agr. Miscellaneous Circular 92. March, 1927.

On *H. ovata* in Tennessee.

On *Quercus alba* in North Carolina and Tennessee.

On *Q. borealis maxima* in Georgia, North Carolina, Ohio, and Tennessee.

On *Q. coccinea* in Tennessee.

On *Q. marilandica* in Arkansas and Tennessee.

On *Q. montana* in Georgia, North Carolina, and Tennessee.

On *Q. myrtifolia* in Florida.

On *Q. rubra* in Florida, North Carolina, and Tennessee.

On *Q. stellata* in Arkansas, North Carolina, New Jersey, and Tennessee.

On *Q. velutina* in North Carolina, and Tennessee.

On *Q. virginiana geminata* in Florida.

On *Ulmus alata* in Georgia.

The disease as known by the writer ranges from Indiana to New Jersey and southward to Arkansas and Florida. It attacks eighteen species of trees of six different genera. It probably attacks other species of the same and of different genera over a larger area than is now reported.

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NEW AND NOTEWORTHY FUNGI—VI[1]

John Dearness

HYPHOMYCETES

Ramularia Chrysopsidis sp. nov.

Spots small and subcircular at first, becoming irregular, lacking definite border, above merely paler than surrounding surface, beneath marked by whitening due to the numerous fascicles of fertile hyphae but becoming brown as these disappear with age. Fertile hyphae hypophyllous, hyaline, narrow, 1 μ, fasciculate, base tuberculate. Conidia fugacious, 6–15 × 2 μ, continuous to 1-septate.

On living leaves of *Chrysopsis mariana;* Southold, N. Y.; Sept. 21, 1919. R. Latham: *3032*. (D. *4404*.)

Ramularia Grantii sp. nov.

Spots pallid, similar on both sides of the leaf but contrasts with surroundings stronger on the upper side, often dark brown in a portion of the border, 0.5–3 cm. long by 0.5 cm. wide, sometimes extending along a vein. Fertile hyphae hyaline, amphigenous but mostly hypophyllous, in small clusters, sometimes a single hypha, scattered over the spot and usually densely congregated along and near the vein, 18–30 × 3 μ. Conidia hyaline, oblong, rounded and often somewhat contracted towards the ends, long-catenate, 1-septate, 15–24 × 3–5 μ.

Parasitic on living leaves of *Angelica genuflexa;* Marysville, Wash.; June 1928. J. M. Grant: *7061*. (D. *6713*.)

The descriptions of *R. Archangelicae* Lindr. and *R. Angelicae* v. Höhn do not admit this species.

Ramularia Ivae Dearn. & Barth. sp. nov.

Spots mostly marginal, pale brown, spreading to the midrib and occasionally beyond it, boundary not definitely marked. Fertile hyphae amphigenous, mostly hypophyllous, densely fasciculate, hyaline, 6–15 × 2.5–3 μ, rising from a shallow tubercular base 10–45 μ thick and 0.1–1 mm. in diameter. Conidia hyaline, oblong, continuous, rarely 1-septate, 12–32 × 3.5–5 μ.

[1] Continued from Mycologia **20**: 246. 1928.

On living leaves of *Iva axillaris* Pursh; Lyman, Wyo.; Aug. 21, 1917. V. Simmons, J. R. Weir: *8976*. (D. *4585*.)

RAMULARIA MITELLAE Peck, var. **Heucherae** var. nov.

This form differs from the type in having smaller and more orbicular spots with a wide, dark brown margin and whitish center. The conidia are 10–19 × 2.5–3 μ.

On living leaves of *Heuchera glabra;* Mt. Rainier National Park, Wash.; alt. 7000 ft.; Sept. 1924. J. M. Grant: *6004*. (D. *5805*.)

Cercosporella Lilii sp. nov.

Spots diaphanous areas extending from the margin to the midrib, seldom crossing it but often occupying most of half of the leaf, marginless or having a brownish diffuse margin, distorting or curving the leaf towards the affected side. Fertile hyphae amphigenous, in very numerous short fascicles, 5–15 × 2.5–3 μ. Conidia hyaline, 2- to 5-septate, not strongly obclavate, densely enough congregated to give a white flocculent appearance to portions of the spot.

Parasitic, exhausting the leaf parenchyma, on *Lilium canadense;* Hudson Falls, N. Y.; July 1, 1919. S. H. Burnham: *322*. (D. *5975*.)

Coniosporium parasiticum sp. nov.

Conidia dark brown, obovate, apiculate, 8–12 × 4–6 μ, growing on obscure, subhyaline, prostrate, short, branching hyphae.

On green cotyledons of *Citrullus vulgaris;* Stirling, Ont.; May 21, 1927. Com.: Prof. J. E. Howitt. (D. *6325*.)

Quite different from *C. Fairmani* and *C. apiosporoides* both on Cucurbit hosts. This seems to be parasitic but it is not proved that it may not be secondary. Its gross appearance on the cotyledons is much like that of *Apiosporina Collinsii* on Juneberry leaves.

Cladosporium subsessile Ellis & Barth.

Parasitic and very common on leaves of *Populus tremuloides* along the river banks. Saskatoon, Sask.; June 1926. Prof. W. P. Fraser.

This species was published as *Cladosporium brevipes* Ellis & Barth. in Erythea **4**: 27. 1896; and distributed as No. *3288* in Ellis and Everhart's N. Am. Fungi. The name was later

emended as above on account of its preoccupation for a species on oak leaves,—N. Y. Rept. **40**: 64. 1894.

In the description in Erythea the authors state that the spots themselves are caused by insects from which it may be inferred that the fungus is secondary. In the Saskatoon material the spots are numerous, circular, 2–3 mm. in diameter and lacking visible evidence of the intervention of insects.

Stigmina Vitis Dearn. & Barth. sp. nov.

Spots irregular, 3–10 mm., becoming confluent, appearing at first on the lower side of the leaf, dull grayish brown, later developing on the upper side, dark brown. Fertile hyphae in thickly scattered fascicles on small tubercles about 35–60 μ in diameter and 30–40 μ high, hypophyllous. Conidia continuous to 3-septate, reaching 30 μ in length, formed of cells variable in size but mostly about 7–10 $\times$ 7–9 μ.

Parasitic on leaves of *Vitis Girdiana* Munson; Riverside, Cal.; Aug. 9, 1924. E. Bartholomew: *8886*. (D. *5659*.)

Septonema formiculum Dearn. & Barth. sp. nov.

Fertile hyphae very short, dark brown, 7 μ in thickness. Conidia black, shining, long barrel-shaped, 15–45 $\times$ 12 μ, 2–7 septate, catenate, as many as 6 or even more in a chain; chains branching.

Producing black patches, 1–3 cm. on decorticated branches of *Morus alba*. The numerous short spore chains resemble so many ants under the low power of the microscope.

Collected at Stockton, Kan.; June 13, 1923. E. Bartholomew: *8199*. (D. *5782*.)

Heterosporium laricinum sp. nov.

Fertile tufts grayish brown, amphigenous, consisting of 2 or 3 to 20 or more erect or ascending brown hyphae, septate, geniculate with up to 5 conidia-bearing knees, 20–225 $\times$ 7–10 μ. Conidia subhyaline to fuliginous brown, oblong-elliptic, asperate, uniseptate, 18–21 $\times$ 6–8 μ.

Common on hanging and fallen needles of *Larix occidentalis* Nutt.; Marcus, Wash.; Aug. 13, 1928. G. G. Hedgcock: *47183*. Another ample collection Sept. 21, 1928. G. G. H. *48469*. (D. *6812*.)

The most vigorous tufts were in clefts produced by an undeter-

mined *Melampsora*. *H. Laricis* Cooke & Massee has hyphae 15–18 μ thick and conidia 50–60 μ long.

Ophiotrichum Verbenae Dearn. & Barth. sp. nov.

Spots visible only on the lower side of the leaves grayish brown, bounded by the strong veinlets, 0.5 cm. wide. Fertile hyphae 1–3 mm. long, creeping, loosely branching in a compound radiate manner, pale brown, septate, nodulose, 4–5 μ thick. Conidia paler, continuous to 5-septate, sometimes shortly catenate, 12–35 × 3.5–6 μ, mostly between 21 and 28 μ long by 4.5 μ wide.

On living leaves of *Verbena urticaefolia;* Birmingham, Ala.; Oct. 4, 1924. E. Bartholomew: *8951.* (D. *5651.*)

CERCOSPORA CHENOPODII Fres. var. **micromacula** var. nov.

On *Chenopodium Boscianum;* Stockton, Kan.; Fungi Columb. No. *2210;* and on probably the same host at Seaford, Del.; C. R. Orton, L. O. Overholts: *8345.* (D. *5651.*)

This differs from the typical form as represented in European and American exsiccati in having whiter, more definitely red-bordered, smaller spots, 1–2.5 mm., looser and longer fertile hyphae up to 120 × 4.5 μ and shorter, often continuous or only up to 2-septate conidia, 30–45 × 6–7 μ.

Cercospora Cryptotaeniae sp. nov.

Spots scattered small, dark brown, angular, veinlet-bounded, 1–3 mm., similar on both sides of the leaf. Fertile hyphae hypophyllous, in numerous, small suberect tufts of 3–7 brownish units, 25–50 × 4–6 μ, continuous or 1 to 2 septate. Conidia sub-hyaline, narrowly obclavate, pluriseptate, 45–90 × 3 μ.

On living leaves of *Cryptotaenia canadensis;* Hudson Falls, N. Y.; July 13, 1919. S. H. Burnham: *400.* (D. *5988.*)

Cercospora Phaseoli Dearn. & Barth. sp. nov.

Spots scattered, numerous, dull reddish brown above, sooty gray beneath, subcircular, immarginate, 0.5–1 cm. Fertile hyphae chiefly hypophyllous, fasciculate, the longer ones torulose, 1–3 septate, brown, 10–60 × 3.5–6 μ. Conidia forming a tomentum-like layer on the lower side of the spot, dilutely colored, attenuate-obclavate, tip obtuse and usually more than half as thick as the base, nucleate, 1–6 septate, 10–150 μ mostly 45–85 × 3–6 μ.

On living leaves of *Phaseolus vulgaris;* Brownwood, Mo.; Oct. 3, 1923. E. Bartholomew: *8516.* (D. *5431.*)

Of four Cercosporae reported on this host and its allies this species seems nearest *C. olivacea*.

Cercospora umbrata Ellis & Holw. var. **maculata** var. nov.

This differs from the type in the spots being definitely maculate and the conidia larger, 30–66 × 3–4.5 μ.

Parasitic on leaves of *Bidens laevis;* London, Ont.; Sept. 13, 1923. Dearness: *5370*.

Helminthosporium lumbricoideum sp. nov.

Hyphae brown, long, up to 2 mm., branches few, diverging at various angles, septate, septa about 15 μ apart, wall 2–3 μ thick. Conidia brown, 10–16 septate, 130–150 μ long, 12–15 μ thick in the middle, evenly attenuated to 6–7 μ at both ends.

Producing a thick dark felt on dead stems of *Vaccinium* sp.; Mt. Baker, Wash.; July 1927. J. M. Grant: *6056*. (D. *6367*.)

Hyphae and conidia are different from those of *H. attenuatum* Cooke & Peck.

Dendryphium brunneum Dearn. & Barth. sp. nov.

Blotches seal-brown, subcircular or irregular, 0.5–5 cm. Hyphae brown, much branched, closely septate, 5–7 μ thick; wall 1.5 μ thick. Conidia pleurogenous, brown, oblong or ellipsoid, narrowing towards the ends, 8–30 × 5–8 μ, 1–6 septate, often nucleate between the septa which are from 4 to 8 μ apart, catenate, some of the chains are long and curving so as nearly to form a circle.

On bark of dead, firm branches of *Sorbus scopulina;* Jenny Lake, Wyo.; July 12, 1924. E. Bartholomew: *8788*. (D. *5712*.)

Stigmella Platani-racemosae Dearn. & Barth. sp. nov.

Beginning as small, scattered, sooty blotches on the lower side of the leaf and extending indefinitely; the upper side over the affected areas tardily becoming brown. The unit masses of short fertile hyphae and conidia dark, subglobose, 40–90 μ. Conidia dark brown, becoming phragmosporous and often muriform, globose to ovoid, 9–18 × 9–12 μ.

Parasitic on leaves of *Platanus racemosa;* Riverside, Cal.; July 9, 1924. E. Bartholomew: *8889*. (D. *5652*.) Related to *S. Platani* (Fuckel.) Sacc.

Stigmella Vernoniae Dearn. & Barth. sp. nov.

Covering the upper side of the leaves with a sooty layer resembling the usual appearance of *Fumago vagans*, numerous small

patches on the lower side. Spores black, globose, 20–30 μ in diameter, made up of cells 5–9 μ in diameter, on very short brownish, branched hyphae 3–4 μ across.

On living leaves of *Vernonia gigantea* (Walt.); Williamsville, Mo.; Sept. 28, 1923. E. Bartholomew: *8474.* (D. *5384.*)

Coniothecium Eriodictyonis Dearn. & Barth. sp. nov.

Sooty blotches occur on both sides of the leaf but more numerous and extensive on the lower side, small and circular at first, 2–3 mm. in diameter, becoming large and irregular, sometimes confluent, affected areas on the upper side finally become red brown. Hyphae 10–37 $\times$ 5–7 μ, septate, brown, single or fasciculate. Conidia brown, uneven or rough but not echinulate, muriform and sarciniform, sometimes phragmosporous, mostly of 4 to 8 cells in a mass becoming coalescent into more or less irregular, dictyosporous masses of 12 to 24 or more cells 5–10 μ in diameter.

On living leaves of *Eriodictyon tomentosum* Benth.; Corona, Cal.; Sept. 8, 1924. E. Bartholomew: *8934.* (D. *5657.*) Superficially this resembles both N. Am. Fungi *3491, Heterosporium Eucalypti* Ellis & Ev. var. *maculicolum* and Fungi Columb. *1171, Heterosporium californicum* Ellis & Ev. ined., which may have been parts of a collection of leaves of *Eriodictyon.*

Glutinium hystricinum sp. nov.

Synnema thickly scattered, black, cylindric, not globose at base, 0.5–0.9 mm. long, hard when dry. Conidia hyaline, elliptic or oblong-elliptic, grumous and nucleate, 20–27 $\times$ 9–12 μ, on rather stout, simple or branched conidiophores, 25–32 $\times$ 3–4 μ.

On dead branches of *Quercus Prinus;* Mattituck, N. Y.; Feb. 28, 1924. R. Latham: *1823.* (D: *5534.*)

Fusarium phacidioideum sp. nov.

Sporodochia phacidioid, nearly circular, somewhat cup-like, surrounded by the cuticle, 0.5–1.5 mm. wide, disk yellowish gray, becoming darker with age until nearly concolorous, scattered. Conidia hyaline, crescentic, acuminate-acute, curved to a semicircle, the outer end sometimes incurved, uniformly 3-septate, 45–75 μ long by 3.5–4 μ thick; conidiophores detach in fascicles, 15–20 μ long.

On dead branches of *Pseudotsuga taxifolia;* Stanley Park, Vancouver, B. C.; Aug. 24, 1924. J. S. Boyce: *1285.* (D. *5666.*)

Exosporium Betheli sp. nov.

Sporodochia minute tubercles, contiguous, seriate, producing black lines between the leaf-scales. Mature conidia dark brown, clavate, almost uniformly 8-celled, 35–51 × 6–8.5 μ exclusive of the hyaline, proximal cell or pedicel which is 15–16 × 5 μ.

On living branchlets of *Juniperus occidentalis* Hook.; Big Bear lake, Cal.; Aug. 2, 1920. Ellsworth Bethel. (D. *5565*.)

The late Professor E. Bethel made several collections of this species and remarked that he always found it associated with *Gymnosporangium inconspicuum* Kern apparently on the mycelium or incipient stage of the rust. Its spores are much larger than those of *E. deflectens* Karst., which are 14–20 × 5–6 μ. In some of the black lines there is a Mycosphaerella, hardly mature. The asci are 78–100 × 6.5–7.5 μ; ascospores not well defined, 1-septate and about 18–24 × 3.5–5 μ.

Exosporium rhoina Dearn. & Barth. sp. nov.

Pulvilli scattered, black, seated in the cortex with a broad flat base, 1.5–3 mm., raising the epidermis into large pustules and rupturing it in a crateriform manner, the flat or sometimes concave top about 1 mm. wide. Conidia brown, 3-celled, round at the top, the lowest cell narrowed to the base, 28–42 × 13–19 μ; fertile hyphae pale brown, short, simple or shortly branched, 6–8 μ thick.

On dead branches of *Rhus glabra;* Moscow, Ida.; June, 1917. C. H. Shattuck, J. R. Weir: *9212*. (D. *4584*.)

LONDON, ONTARIO,
CANADA

THE PRODUCTION OF NORMAL SPOROPHORES IN MONOSPOROUS CULTURES OF AGARICUS CAMPESTRIS

Edmund B. Lambert

(With 1 Text Figure)

Since 1918, when, Bensaude (**1**) first called attention to heterothalism in the *Agaricaceae*, the sex phenomenon in that group has been investigated in numerous species of several genera. This work has recently been summarized by Kniep (**5**). As far as the writer is aware there have been no investigations of this question

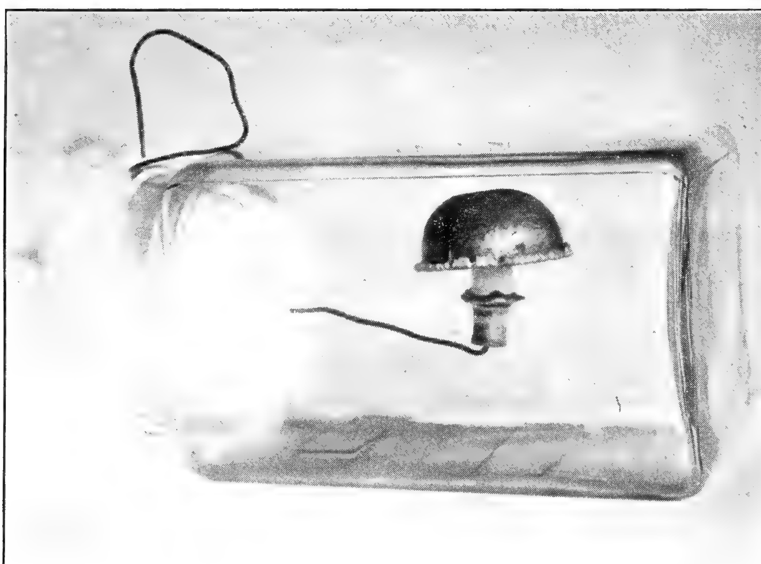

Fig. 1. Apparatus used to gather spores on glass microscope slides under aseptic conditions.

in the case of cultivated mushrooms. In the United States there are several distinct varieties of cultivated mushrooms some of which are probably not *Agaricus campestris* (**2**, 6). The variety *Agaricus campestris* which is most extensively cultivated has 2

spores on a basidium and is known to the trade as the "Snow White" variety. As the first step in the investigation of the sex phenomenon in this variety the writer has made monosporous cultures and has grown normal sporophores from them.

Spore prints were made under aseptic conditions. This was accomplished by a modification of the method used by Ferguson (**3**). The sporophores were selected when slightly expanded but before the veil had ruptured; they were submersed in a 1 to 1000 solution of bi-chloride of mercury for 3 minutes and dried off over a bunsen burner; they were then placed in a candy jar, which had been autoclaved, and arranged as shown in FIGURE 1. In these containers sporophores as a rule expanded, ruptured the veil and shot spores in a few days. The spores were then transferred, from the glass slides on which they were collected, in a loop of sterile distilled water to liquid agar, cooled to 45°C. A synthetic agar was used.

It was made up as follows:

Magnesium sulphate	0.5 grms.
Potassium acid phosphate (monobasic)	1.0 "
Sucrose	3.0 "
Maltose	1.0 "
Dextrose	1.0 "
Agar agar	12.0 "
Distilled water	1.0 liter

Although there was considerable difference in the percentage of germination of spores from different spore prints, as a rule germination was plentiful in this agar at room temperature (22°–25° C.).

Single spore cultures were made by the dilution culture method in petri dishes using the technique suggested by Keitt (**4**). Isolated spores which were just beginning to germinate were picked up in a block of agar and transferred to fresh petri dishes of sterile agar. The growth of the mycelium from the spore was watched at daily intervals. Further transfers were not made until the mycelium had grown out from the original block of agar. When making spawn by transferring these agar cultures to sterile manure, a higher percentage of successful transfers was obtained by placing the bottles of sterile manure in a moist chamber for a few days after the transfers were made.

Nine single spore cultures were made in this way and spawn

from them was placed four feet apart in standard shelf beds of composted horse manure. All possible matings were also made and planted in a similar way.

In all cases normal sporophores developed. The experiment was repeated 5 months later and again normal sporophores developed from single spore cultures. There is, of course, the possibility that viable spores of *Agaricus* were present naturally in the compost and germinated when approached by the mycelium running from the spawn. However, it seems highly improbable that the sporophores were produced by chance matings in the beds for three reasons: first, in all cases the sporophores appeared first immediately above the pieces of spawn; second, all of the sporophores were typical of the "Snow White" variety; and third, no mycelium of *Agaricus* appeared in several check beds which were not spawned. To the writer the evidence seems quite conclusive that this variety is capable of producing vigorous normal sporophores from single spores.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

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NOTES AND BRIEF ARTICLES

The new rust book by Dr. J. C. Arthur and his collaborators, which was announced in the March–April Mycologia, appeared during the summer. The work, which covers all phases of the rust question, consists of 446 pages of text profusely illustrated and 186 text figures, both drawings and half tones. While the work is not taxonomic, a brief discussion of this problem is incorporated. A list of families and genera is included and the points of departure from the system used in North American Flora emphasized. Some of the more recently proposed generic names such as *Dicaeoma* and *Nigredo* have been discarded in favor of the more commonly recognized names *Puccinia* and *Nigredo*. The book will doubtless be widely used by mycologists in every part of the world.

Proposed amendments to the "International Rules of Nomenclature," widely distributed by J. C. Arthur last March and printed in the May–June number of Mycologia (**21**: 172–174), have been revised and will appear in their final form in a recent number of *Science*.

Only two changes are advocated. The first proposal would make 1753 a uniform date for the beginning of priority, for which there appears to exist much favorable sentiment. The second proposal would make names applied to rusts under the genus *Uredo* equally valid with those given to the telial stage. This has the effect to recognize all names applied to the sporophytic stage of the rust, and in consequence conserves more names in current use than the rule as it now stands.

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